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AMERICAN STATISTICAL ASSOCIATION

CONTENTS *for* JUNE 1941

The Meaning of Unemployment Statistics	*Aryness Joy*	167
Dynamics of Labor Supply	*Howard B. Myers*	175
Wholesale Price Indexes	*Francis McIntyre*	185
Cost of Living Indexes	*Robert A. Sayre*	191
Price Indexes as Viewed from the Standpoint of the National Defense Program	*Martin Taitel*	201
An Appraisal of Index Numbers of Prices Farmers Pay	*Joel Dean and Mary Hilton Wise*	210
Principles and Procedures for Putting Across Business Statistics Reports to Executives	*John W. Boatwright*	219
How the Librarian Would Like to Find Statistics	*Rose L. Vormelker*	225
How a Newspaperman Likes Statistics Presented	*John W. Love*	233
Problems Concerning the Availability of Census Data	*Halbert L. Dunn*	240
Observation on Correlation Analysis	*A. H. Mowbray*	248
Corporate Earnings on Share and Borrowed Capital in Percentages of Gross Income (1918-1940)	*Leland Rex Robinson*	253
Sources and Uses of Corporation Funds	*Arthur B. Hersey*	265
The Validity and Significance of Male Net Reproduction Rates	*Robert J. Myers*	275
The Relation Between the Design of an Experiment and the Analysis of Variance	*A. E. Brandt*	283
Some Practical Uses for Hyperbolic Grids	*Herbert G. Smith*	293
Notes and Discussions		299
Book Reviews		303

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The American Statistical Association is a scientific and educational organization. Its membership is not confined to professional statisticians but includes economists, business executives, research directors, government officials, university professors, and other persons who are seriously interested in the application of statistical methods to practical problems, in the development of more useful methods, and in the improvement of basic statistical data. Engineers, mathematicians, biologists, actuaries, sociologists, psychologists, and representatives of many other professions are included in the membership of the Association. Information about the Association and membership application forms may be secured from the Secretary, R. L. Funkhouser, 1626 K Street, N.W., Washington, D. C.

The 103rd Annual Meeting of the American Statistical Association will be held in New York City, December 27 to 30, 1941. With a few exceptions the sessions are open to the public.

Chapters of the Association have been organized in important cities in the United States. Information concerning the meetings of these chapters may be secured from the District Representatives listed on another page.

The Editors welcome the submission of articles and notes for possible publication in the JOURNAL. Manuscripts should be sent to the Editor, Journal of the American Statistical Association, 1626 K Street, N.W., Washington, D. C. Books for review should be sent to the Review Editor, Glenn E. McLaughlin, 210 Normandy Building, 1626 K Street, N.W., Washington, D. C. Authors who wish suggestions about the preparation of manuscripts and charts or information about editorial policies should address their inquiries to the Editor.

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CONTENTS

ARTICLES

The Meaning of Unemployment Statistics . . . . . ARYNESS JOY 167
Dynamics of Labor Supply . . . . . HOWARD B. MYERS 175
Wholesale Price Indexes . . . . . FRANCIS MCINTYRE 185
Cost of Living Indexes . . . . . ROBERT A. SAYRE 191
Price Indexes as Viewed from the Standpoint of the National Defense Program . . . . . MARTIN TAITEL 201
An Appraisal of Index Numbers of Prices Farmers Pay . . . . . JOEL DEAN AND MARY HILTON WISE 210
Principles and Procedures for Putting Across Business Statistics Reports to Executives . . . . . JOHN W. BOATWRIGHT 219
How the Librarian Would Like to Find Statistics ROSE L. VORMELKER 225
How a Newspaperman Likes Statistics Presented . . JOHN W. LOVE 233
Problems Concerning the Availability of Census Data HALBERT L. DUNN 240
Observation on Correlation Analysis . . . . . A. H. MOWBRAY 248
Corporate Earnings on Share and Borrowed Capital in Percentages of Gross Income (1918–1940) . . . . . LELAND REX ROBINSON 253
Sources and Uses of Corporation Funds . . . . ARTHUR B. HERSEY 265
The Validity and Significance of Male Net Reproduction Rates . . . . . ROBERT J. MYERS 275
The Relation Between the Design of an Experiment and the Analysis of Variance. . . . . A. E. BRANDT 283
Some Practical Uses for Hyperbolic Grids. . . . HERBERT G. SMITH 293

NOTES AND DISCUSSIONS

Methods of Family Living Studies, A Reply to the Review. . . . . ROBERT M. WOODBURY 299
Rejoinder . . . . . CARLE C. ZIMMERMAN 300
Reply to the Rejoinder . . . . . ROBERT M. WOODBURY 302

BOOK REVIEWS

ARKIN, HERBERT, and COLTON, RAYMOND R. *Graphs, How To Make and Use Them.* Elmer C. Bratt 315
BENHAM, FREDERIC. *Great Britain under Protection.* Clifford L. James . . 317
BERNSTEIN, BLANCHE. *The Pattern of Consumer Debt, 1935–36.* Louis N. Robinson 322
CENSUS, U. S. BUREAU OF THE. *Maps of Selected Industries Reported at the Census of Manufactures, 1937.* Oscar L. Endler 318
COLTON, RAYMOND R., see ARKIN HERBERT.
DAHLBERG, GUNNAR. *Statistical Methods for Medical and Biological Students.* Gaius E. Harmon 312
ECKERT, W. J. *Punched Card Methods in Scientific Computation.* Francis McIntyre 314
EMERSON, HAVEN, and HUGHES, HARRIET E. *Population, Births, Notifiable Diseases, and Deaths, assembled for New York City, N. Y.: 1866–1938.* Halbert L. Dunn 310

Continued on next page

BOOK REVIEWS (*Continued*)

FOOD RESEARCH INSTITUTE, Stanford University. *Wheat Studies of the Food Research Institute*, Volume XVII, Numbers 1, 2, 3, and 4. Roland S. Vaile 320
HARDY, CHARLES O. *Wartime Control of Prices*. Dan Throop Smith . . 321
HUGHES, HARRIET E., see EMERSON, HAVEN.
JENSS, RACHEL M., and SOUTHER, SUSAN P. *Methods of Assessing the Physical Fitness of Children*. John R. Miner 309
KELLEY, TRUMAN L. *Talents and Tasks, Their Conjunction in a Democracy for Wholesome Living and National Defense*. Martin F. Fritz 307
KISER, LOUISE K., see LORIMER, FRANK.
LASORSA, GIOVANNI. *Statistica Economica con Riferimenti alla Organizzazione e alle Fonti*. Antonio Ciocco 313
LONG, CLARENCE D., JR. *Building Cycles and the Theory of Investment*. John R. Riggleman 316
LORIMER, FRANK, WINSTON, ELLEN and KISER, LOUISE K. *Foundations of American Population Policy*. J. J. Spengler 305
MARSH, LEONARD C. *Canadians In and Out of Work*. P. Sargant Florence . 303
NOTESTEIN, FRANK W., see STIX, REGINE K.
SCHUT, M. J. *Tinrestrictie en tinprijs* (Tin restriction and tin price). Tjalling Koopmans 319
SIMS, LEWIS B. *The Scholarship of Junior Professional Appointees in the Government Service*. James C. Charlesworth. 306
SNEDECOR, GEORGE W. *Statistical Methods Applied to Experiments in Agriculture and Biology*. C. H. Goulden 313
SOCIAL SECURITY BOARD. *Old-Age and Survivors Insurance Statistics*. W. S. Woytinsky 308
SOUTHER, SUSAN P., see JENSS, RACHEL M.
STAFFORD, PAUL TUTT. *Government and the Needy, A Study of Public Assistance in New Jersey*. Elizabeth W. Gilboy 304
STIX, REGINE K. and NOTESTEIN, FRANK W. *Controlled Fertility, An Evaluation of Clinic Service*. Margaret J. Hagood. 309
WINSTON, ELLEN, see LORIMER, FRANK.

Publications Received 325

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THE MEANING OF UNEMPLOYMENT STATISTICS*

By Aryness Joy
Bureau of Labor Statistics

This is the end of a decade of estimating unemployment. The Census Bureau will soon issue its preliminary report from the Census of 1940.[1] We can then all re-examine and appraise the statistics we have been using for the past 10 years. Whether this initial Census report shows 7 or 8 or 10 or 12 million men and women unemployed in the spring of 1940, in itself matters little for the course of this discussion. Many of the same difficulties that all estimators have encountered in obtaining satisfactory statistical tools for the formation of public policy in this field will still remain, even after the 1940 Census has provided new bench marks.

The problem is how to go forward in the future with a program which will provide prompt, accurate, and useful measures of the amount of employment and unemployment and the size and characteristics of the labor supply. It is such a program that is here presented.

Let us begin with an examination of some of the widely used statistics of unemployment—those of the Congress of Industrial Organizations, the American Federation of Labor, and the National Industrial Conference Board, to name only three. In the spring of 1940, when the Census was taken, the C.I.O. showed 11.5 million unemployed, the A.F.L. 10.3 million, and the N.I.C.B. 9.2 million. In mid-October, after several months of a rapidly expanding defense program, they ranged from 8.9 million as reported by the C.I.O. down to 6.65 million from the N.I.C.B. Whether the Census proves them to be approximately correct or to be in error by 1, 2 or 4 million is not the primary problem.[2] The

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

[1] This report was issued on January 6, 1941, based upon a 5 per cent sample chosen by selecting 4 out of the 80 lines on each enumeration sheet, *before editing*.

[2] The tabulations indicate that in the last week of March 1940 there were 7.5 million persons seeking work or engaged in emergency work. The Census release calls attention to the fact that the number of emergency workers shown by the tabulations is about one million short of the number which would be expected on the basis of the records of the emergency work agencies. It seems probable that roughly half of these were enumerated as employed in private or regular government employment, because of confusion in the minds of the enumerators or because of the reluctance of emergency workers to report their status correctly. Most of the remaining misclassified emergency workers seem to have been reported as not in the labor force. The 472,000 recipients of N.Y.A. student aid no doubt accounted for a large part of this group, and most of them were probably reported as in school. Thus it appears likely that the total number of unemployed, defined as persons seeking work plus emergency workers other than N.Y.A. students, was about 8 million.

problem is this: Given the new bench marks from the Census of 1940, will revised estimates, continued along the same lines, yield satisfactory results 1, 3, 5 or 10 years from now, or can we devise other, improved statistical tools which will better serve purposes of public policy?

These three estimates and all of the others currently published use basically the same method. It is set up like a simple problem in subtraction. There is, first, an estimate of the total labor force, so-called, in this case, some variant of the familiar figure of the 48.83 million gainfully occupied from the Census of 1930, currently estimated in the neighborhood of 55 million. Second, there is an estimate of the total number of persons employed at any given time, in the spring of 1940 in the neighborhood of 43 to 46 million. We subtract: The remainder is so-called *unemployment.* That is, unemployment is a residual obtained by subtracting estimated employment from the estimated total labor force. If, then, there are errors in estimating the two large basic figures, they may well combine in the final estimate of unemployment to make a large percentage error in this much smaller figure. It has long been my opinion that unemployment estimated in this manner as a statistical residual has, and always will have, such great possibilities for error that this technique should be abandoned entirely and our combined efforts should be directed toward devising new and better methods for obtaining estimates of total unemployment. The reasons for this conclusion are given in more detail below.

In April 1930 all three key figures—the labor supply, employment and unemployment—were known. Great difficulties have been encountered in keeping these figures up to date. Many of these difficulties are still present and will be present after the Census of 1940 provides new bench marks.

The greatest difficulty, perhaps, is in the current estimates of the total labor supply. Starting with a figure for the gainfully occupied as reported in the Census of 1930, a current figure has been provided by estimating the population of each age group separately for men and women, and then computing the working population in each group. This is done, ordinarily, by assuming that the same proportion of men and women in a given age group were in the labor force throughout the decade as in 1930. The principal recognized exceptions are the very young and the very old workers, who are known to be less numerous; how much less numerous can only be guessed. Thus, the labor supply has been estimated to increase month by month and year by year by a fixed amount, on a straight line basis. Only the returns from the Census of 1940 can indicate whether the assumptions implicit in these fig-

ures were, in fact, justified.[3] It is likely, however, that estimates of the labor supply are far from satisfactory for two reasons:

(1) Because a great depression or any other major shift in general economic conditions will almost inevitably change the size and character of the labor supply. For the future, then, the question is whether, given the new Census bench mark for March 1940, estimators of unemployment will not almost immediately be in the same kind of difficulty they have been in for the past decade. Our tremendous defense program probably constitutes as great an upheaval for the American industrial system as the depression that began late in 1929, although it is of a different character. The ink will scarcely be dry on the Census figures before they are in fact so thoroughly out of date that we will again be only guessing if we apply the same techniques that have been used in the past and estimate labor force as a rising straight line. For example, during the World War period it has been estimated by the National Industrial Conference Board that employment exceeded by about 3 million their estimate of normal labor supply. This indicates the extent to which abnormal economic conditions may affect the size of the labor force.

(2) The second basic criticism of estimates of the labor force is presented by Mr. Myers. The change in the labor force is not constant or slow; it is very rapid—particularly from season to season within each year. Thus, for example, the effective labor force may change by as much as 3 million within a few months, as school children, housewives, members of farm families, etc., come and go from the active labor market. None of the current compilations of unemployment have estimated these changes nor could they possibly have done so. Yet for purposes of national policy in an expanding labor market, such as that of today, information on the size of the labor force is as important as information

[3] The Census figure of 52.8 million persons "in the labor force" is substantially smaller than would have been expected on the basis of the 1930 Census data. According to Mr. Loring Wood, of the Bureau of Labor Statistics, "This is the principal reason why the number unemployed was smaller than many estimators expected it to be. The discrepancy is pronounced even if comparisons are limited to the age groups 20–64 years, where the effects of the inclusion of inexperienced workers, decreases in child labor, and the trend toward earlier retirement, are largely eliminated. An adjustment of the 1930 figures to allow for changes in population and the expected increase in the proportion of women in the labor market would lead to an estimate for 1940 of 48.5 million "gainful workers" in these age groups—37.1 million men and 11.4 million women. The preliminary sample tabulations show 35.6 million men in the labor force, or 1.5 million less; and 11.2 million women, or 0.2 million less. Even in the more completely employed group of men aged 25 to 44, the discrepancy is substantial. While 97.5 per cent of the men in this age group were reported as gainfully occupied in 1930, the proportion in the labor force in 1940 was only 94.7 per cent.

"It is possible, of course, that there have been significant shifts during this decade in the proportion of the population which is, in reality, in the labor force. But such shifts probably were not large enough to account for the discrepancies noted, and it seems fairly certain that 1930 "gainful workers" and 1940 "labor force" cannot be regarded as comparable groups."

on unemployment, and a figure which may be in error by several millions is of little value.

There is, then, the second basis segment of unemployment estimates, namely, the figures of *employment.*[4] Estimates of employment in nonagricultural occupations have been made currently by the Bureau of Labor Statistics for some years. They are pieced together like a patchwork quilt from information from a great variety of sources. The total size of the employed group in the Bureau's figures and those of the agencies which estimate unemployment is initially determined from the Census of 1930, by subtracting the number of persons unemployed from the number gainfully occupied, with certain adjustments which vary according to the estimator.

Going forward, however, almost all of the existing data are reported by employers, not by the workman or a member of his family as in a Census enumeration. Consequently this 1930 total has been broken up into industrial segments, based upon industrial censuses or other comprehensive measures, leaving a residual to be divided up among the less well-organized and well-defined industries and occupations. The changes in these figures since 1930 are based largely upon changes in the number of persons on payrolls, as reported month by month by sample groups of employers in the more highly organized industries. For about 40 per cent of the working population there are fairly reliable current sources of information. For the other 60 per cent, including agriculture, the statistics are little better than informed guesses.

For manufacturing, mining, the railroads, the public utilities, much of wholesale and some of retail trade, hotels, some parts of finance and banking, part of the public construction industry, Federal employment, and certain other segments of industry, there are quite satisfactory monthly reports of employment to the Bureau of Labor Statistics, the Interstate Commerce Commission, the Federal Power Commission, the Maritime Commission and other agencies. These reports can be checked for general level, as the years go by, by comparison with the industrial censuses and adjusted to the reports of those censuses. Yet, as we all know, sizable errors have developed, even in some of these best-reported figures, such as manufacturing, because of the nature of the sample.

There remains, then, the 60 per cent of the working population for which current information on changes in employment is very unsatis-

[4] The 1940 Census total for employed persons, including the group not at work but with jobs, proved to be not seriously out of line with the estimates commonly used. The Census figure, however, includes 1.3 million persons who were reported as having jobs though not actually at work, some but not all of whom are included in current estimates as employed.

factory. It includes the very important private construction industry, state and local governments (until very recently at least), water and motor transportation, real estate and building management, all types of small stores and individual services, casual labor, domestic service, the professions and independent businesses, and agriculture. For these lines of work, information between decennial censuses can only be described as good guesses (or bad ones, as the case may be). It should be remembered also that there is no way of knowing when there is a net movement to or from these unreported industries into those for which reports are available. Thus, during the depression, there is reason to believe that many people who lost their jobs in factories or mines found means of living through performing personal services or starting small enterprises of their own, but because there was no way of measuring the number of such transfers it is not unlikely that there has been an underestimate of employment and an over-estimate of unemployment during the depression. Now, the reverse is probably true; small individual builders, for example, may be going into the construction of army cantonments where their employment will be statistically reported for the first time. Employment will go up, unemployment will go down, although their transfer in reality means no net change in either figure.

For some of these formerly unreported occupations, current data are now becoming available through the Social Security Board, but there remains and will remain after the 1940 Census is complete a very large segment of the working population for which the method of direct reports on the number of employees at work for representative employers will never be satisfactory. Although great progress has been made in the past decade in the improvement of employment statistics, both with respect to the number of industries covered and the accuracy and representativeness of the reports, I think it must be recognized that we have pushed the technique of sample reports by employers about as far as it will go.

For these reasons, if we continue to follow the patchwork quilt method of estimating total employment as we have done in the past decade, we must expect continued errors of 1, 2 or more millions of workers. In a total employment figure of over 40 million this may not be of great importance if the *direction* of the change is correct. In estimating unemployment, however, if an error of 1 or 2 million in employment is added to another 1 or 2 million error in the estimate of the labor supply, the resulting combined error of 2 or 3 or 4 million may be very important in an unemployment estimate of 8 or 10 million. It may amount to as

much as 50 per cent. This is not imagination. We know that in the different seasons of the year an error of this magnitude is almost inevitable because of seasonal variations in labor supply alone, of which present estimates take no account. No set of figures with errors of this size can have much meaning.

Yet it is of the utmost importance to know and to know promptly and often—much more often than once in 10 years—how many people are unemployed. It is equally important to be able to relate unemployment to the size of the available labor force and the number who are at work. Guesses will not serve.

Moreover, even after these great global totals are obtained, we still need to know far more about the unemployed and the employed than we now know. Who are they? Are they the young or the old; are they experienced or inexperienced; are they in cities or in rural areas; are they merely laid off because of seasonal slack in their usual occupation; are they now actively looking for work; are they in hopelessly depressed areas? This kind of question can never be answered by building up dubious estimates of the total labor supply and subtracting equally dubious estimates of employment.

What, then, is the solution? I should like to propose not one set of statistics, but an entire battery of related information in order to answer the general question as well as a number of special questions which are so essential to sound formulation of public policy.

First, let us recognize that if we are to estimate the size of the labor force, the total number employed and unemployed, we must do so *directly* by a sampling technique, and abandon our present techniques. If we want to know whether a man is unemployed, we should ask him; we should not try to find him by subtraction. The public is now quite accustomed to the idea of sampling, thanks to the numerous public opinion polls, and statisticians are much more familiar with its actual limitations in social and economic fields.

I should like to suggest, therefore: First, a small monthly sample directly counting the unemployed, the employed and the persons in the labor force, using the Census of 1940 as a bench mark and following its general definitions. The valuable work in sampling for this type of information conducted by Mr. Howard Myers and Mr. John Webb of the Work Projects Administration should make it possible to put such a monthly system into operation quite soon after the 1940 Census data become available. If the sample is small, the collection can be prompt and the data will be sufficiently up-to-date to be really useful. In such a sample an urban-rural classification should be possible, and, on occa-

sion, a special question or two might be added regarding the characteristics of the unemployed.

Second, I should like to urge a comprehensive Census of Population, confined to a few basic questions, once every five years; and third, large sample enumerations by the Census Bureau once every two years. We should, by now, know the dangers of getting too far from base, if any kind of sampling technique is to be used.

Even such a valuable set of estimates of the labor force, of employment and unemployment will leave many questions still unanswered, merely because any comprehensive total provides only a general picture and necessarily conceals many diverse problems. In analyzing the unemployment problem, for example, it is important to know *where* the unemployed are and what kinds of skills and experience they have. The skill of the labor force becomes doubly important today in a rapidly expanding labor market. Such questions as these can best be answered through registration at the offices of the Bureau of Employment Security of the Social Security Board in connection with its work of placement and of payment of unemployment compensation. It is too costly and too slow to get information on skills and training by a census or by direct sampling techniques. Registration at employment offices will provide an adequate approximation for most purposes.

Moreover, as the Social Security system expands to take in other types of work and smaller firms, particularly for unemployment insurance, there will be many generally useful statistics as a by-product of its operations. Thus, the number of persons registered as unemployed and either receiving or awaiting unemployment insurance plus those who have recently exhausted their benefits will in itself be a measure of a very significant segment of employment. It will never measure total unemployment, because the coverage of the Social Security system is not complete, but it will indicate the direction of the change in the load of unemployment due to lay-offs by employers, and it will tell us much more than we now know about the location and the sources of *industrial* unemployment. Such a measure of unemployment is commonly used abroad; it is just developing here and we should all learn to use it.

With regard to *employment*, reports on changes in employment in the large industries which can be measured with some degree of accuracy are the best and most comprehensive of industrial barometers. Their importance should not be minimized. They are a key to the current changing industrial situation, particularly to the progress of the defense program. They should be made more complete and more precise by more critical analysis of reports from employers. But it seems clear that

we should concentrate our efforts in measuring employment by the method of reporting payroll totals in the fairly well-organized large-scale industries, where the employer-employee relationship is significant, and devise some new techniques (probably sampling) for finding changes in the number of self-employed and of persons engaged in small scale enterprise.

Lastly, a coordinated current analysis of all of the reports on employment and unemployment now at everyone's command, couched in terms which the ordinary man can understand, is badly needed. Most of all, after a decade of estimating unemployment, there should be a frank recognition of the inadequacy of the statistical tools in use for the past ten years. The Census of 1940 should be made a landmark for more satisfactory statistics in this field.

DYNAMICS OF LABOR SUPPLY*

By Howard B. Myers, *Director of Research*
Work Projects Administration

The subject of short-run changes in the supply of labor has been given far too little consideration by economists and statisticians. Attention thus far devoted to this field has been almost wholly turned, first, toward measurement of the volume of unemployment and of employment at a given time, and second, toward description of the characteristics of the employed and unemployed groups in cross section. In many discussions it has been assumed that the supply of labor, over short periods, is substantially fixed.

The reasons for this neglect are not hard to find. They relate mainly to the recency with which the need for such information has come to attention, to the absence of data on which a realistic description could be based, and to serious technical difficulties which stood in the way of securing such data quickly and accurately on a recurring basis.

The necessity for greater control of economic and social processes and the rapid extension of government into new fields of activity have brought a growing demand for current data regarding short-run labor-market fluctuations. This demand has been sharply stimulated by the defense emergency and by the frequently expressed fear that the labor supply may prove inadequate to meet the accelerating requirements of the rearmament program.

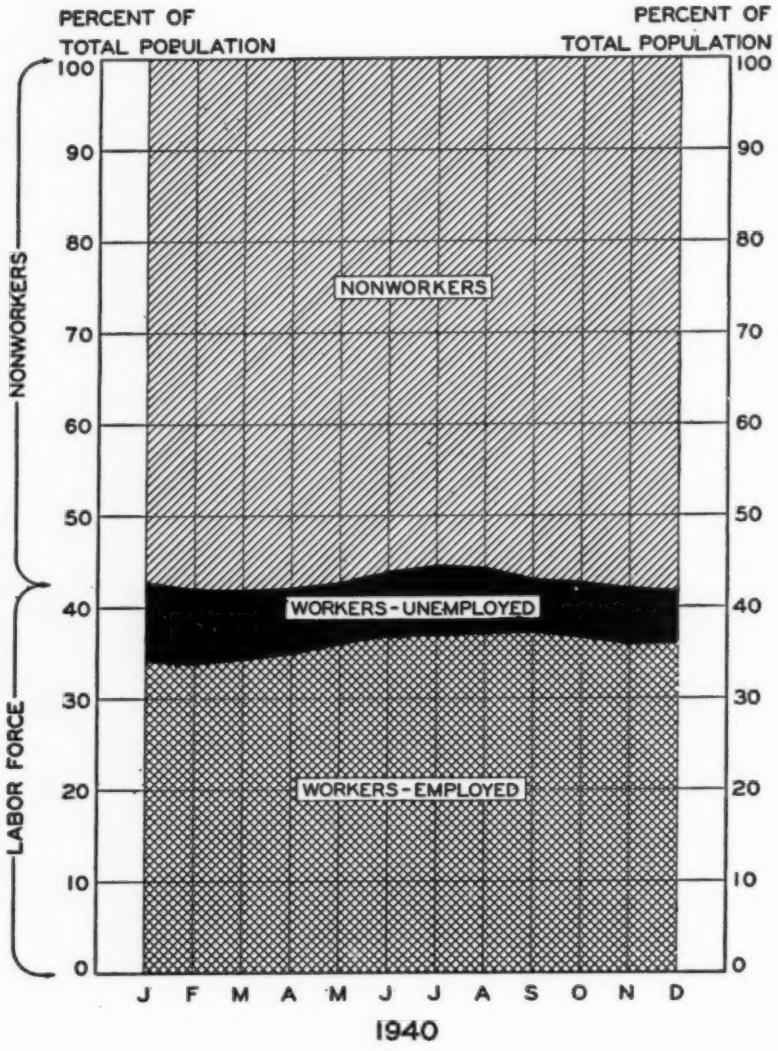
In recognition of the inadequacies of existing data the WPA started several years ago to work out a new approach to the problem of describing and analyzing the dynamic aspects of the labor market. In January 1940 the WPA initiated its *Monthly Report of Unemployment*, the first attempt by any agency to provide accurate measurements of unemployment, employment and the size of the labor force on a systematic basis.

In operation this survey uses the principle of the public-opinion polls. The superiority of the poll method results from the fact that labor-market activity is measured directly rather than estimated indirectly. The WPA survey interviews a carefully selected cross section of the total population. No additions or subtractions, based on assumptions as to unemployment reported in the census, net average increase in the labor force, or changing age structure, are necessary with the poll method; such assumptions are essential to all other methods. The result of

* Revision of a paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

CHART I

LABOR-MARKET STATUS OF TOTAL POPULATION
JANUARY–DECEMBER 1940
(Percentage Estimates)



Source: WPA Monthly Report of Unemployment

the poll procedure is an extremely fast and sensitive report on the state of the labor market that takes full account of changing conditions.

Each month a report is obtained concerning the activity engaged in during a specified week by each member of the sampled households who is 14 years of age or over. All such persons are asked whether they were at work, on emergency work, or actively seeking work during the week. These groups constitute the current labor force. Persons who are not engaged in any of these activities—that is, the nonworkers—are asked the reason for not seeking work. In addition to these items the schedule calls for information on certain personal and employment characteristics of the persons included in the sample.

The sampled households are selected at random within a group of sample counties chosen to be representative of the United States for the characteristics under observation. At the end of the year the survey was operating in 50 counties. Within these counties the sample covered approximately 20,000 households, including some 28,000 workers. The survey covers the week preceding the fifteenth of each month and estimates for the United States are completed before the end of the month in which the data are gathered.

A few of the findings of the survey will be presented briefly in this paper. While the period thus far covered is short, it is believed that certain conclusions may safely be drawn from the data already available.

Chart I and Table I classify the total population broadly according to the activities in which they were engaged during a specified week in each month of 1940. The employed and unemployed groups, taken together, constitute the labor force, which ranged roughly from 40 to 45 per cent of the total population during the period.[1] The remaining 55 to 60 per cent of the population is composed of nonworkers.

The major reasons for nonworker status were: Under 14 years of age, unable to work because of old age or handicap, engaged in housework at home, and in school. As is to be expected most of the nonworker categories exhibited considerable stability during the period. Students were an exception; this category decreased sharply during the

[1] As used in the survey the employed group includes persons 14 years of age or over who worked for pay or profit during the survey week in private or nonemergency government employment, or who had a job from which they were temporarily absent during the week.

The unemployed group includes persons 14 years of age or over who were not employed (as defined above) and were actively seeking employment, and those who worked during the week at public emergency work (WPA, NYA, CCC, etc.).

The sum of the employed and unemployed groups constitutes the labor force during the survey week.

These definitions are equivalent to those used in the 1940 Census of Population.

TABLE I

LABOR-MARKET STATUS OF TOTAL POPULATION*
JANUARY–DECEMBER 1940

(Percentage Estimates)

Month	Population	Labor force			Nonworkers
		Total	Employed	Unemployed	
January	100.0	42.5	34.2	8.3	57.5
February	100.0	41.7	33.9	7.8	58.3
March	100.0	41.6	34.3	7.3	58.4
April	100.0	41.8	34.9	6.9	58.2
May	100.0	42.4	35.9	6.5	57.6
June	100.0	43.7	37.0	6.7	56.3
July	100.0	44.3	37.0	7.3	55.7
August	100.0	44.1	37.2	6.9	55.9
September	100.0	42.8	37.3	5.5	57.2
October	100.0	42.5	36.7	5.8	57.5
November	100.0	41.9	36.0	5.9	58.1
December	100.0	41.9	36.2	5.7	58.1

Source: WPA Monthly Report of Unemployment.
* Figures subject to revision.

summer months, regaining approximately its former size as schools opened in the fall. The fact that the remaining categories changed little in total does not mean, however, that the individuals included all maintained the same status throughout the period. As will be noted later considerable amounts of cross-shifting by individuals occurred during the year.

Shifts among the worker groups were considerably more marked. Total employment rose sharply and rather steadily from February through September. Most of this increase and most of the subsequent decline were caused by marked seasonal changes in agricultural employment. The total employment increase from February to September was approximately 4.7 millions, of which nearly a third, or about 1.4 millions, had been lost by the end of the year.

Note, however, that the total labor supply also fluctuated sharply. Reaching its low for the year in March, the labor force rose to a peak in July, thereafter decreasing steadily through November. The labor supply increased by fully 3.8 millions during the four spring and early summer months. In the remainder of the year it decreased by about 3.2 millions, thereby losing nearly 85 per cent of its former gains.

The causes of these sharp fluctuations have not yet been fully analyzed. It is clear that a good share of the increase represents students who obtained work or were looking for work during summer vacations, and that a considerable proportion of the decline in the fall was caused by students leaving the labor market to return to school. It should be pointed out, however, that the great bulk of students dismissed from

school did not enter the labor market; most of this group went on vacation for the summer. Rural nonschool youth and seasonal agricultural and other outdoor workers constituted another important source of growth of the labor supply during the spring and early summer. Most of these were presumably engaged in or seeking farm work.

It should not be assumed that these additions to labor supply can be dismissed as of little consequence merely because most of them, or their equivalents, removed themselves from the market later in the year. In the first place, the data available indicate clearly that large numbers of them secured jobs, hence diminishing the effect of marked employment gains on the supply of previously unemployed workers. In the second place it appears quite possible that large numbers in this group would have remained in the labor market in the fall had jobs been available for them.

The volume of unemployment, including emergency workers, can be expressed as the difference between the total labor supply and the total volume of employment. Thus it is obviously affected not only by employment changes but also by increases or decreases in the total labor force. What were the net effects of the movements of both of these factors on unemployment during the year?

Starting at a high level in January, unemployment declined steadily through May, aided for most of the period both by employment gains and decreases in labor supply. Simultaneous gains in both employment and unemployment were reported for June, when a marked increase in the labor force more than offset the increase in employment. A further increase in unemployment was reported for July, followed by a decline in August. In September unemployment dropped very sharply, due primarily to the marked decrease in the supply of labor in that month. Unemployment rose in October and November, largely due to sharp losses in agricultural employment, and declined slightly in December primarily as a result of the stimulus of Christmas trade on employment.

The findings of the first year of the WPA survey serve as vivid illustration of the fact that the dynamics of labor demand have their counterpart in dynamics of labor supply. They demonstrate that the supply of labor, far from being fixed, in fact fluctuates sharply during short periods of time. They suggest further that estimates of unemployment lack realism unless they allow for rapid fluctuations in labor supply over and above the net annual increment to total supply. For example, during the period March–July employment increased by fully 3.8 millions. These gains, however, were almost exactly offset by increases in the supply of labor and as a result the volume of unemployment showed no change.

The national movements in employment, labor force, and unemployment which have been sketched are themselves the net results of a variety of geographical and urban-rural changes which often differ widely. As a single illustration we may take the changes occurring between April and May 1940. We shall divide the sample counties into, first, the counties containing the 5 largest cities of the country, second, all other counties with a total population of 45,000 or more in 1940, and third, those counties with a population of less than 45,000 in 1940. For convenience these groups will be called, respectively, metropolitan counties, urban counties, and rural counties.

TABLE II

LABOR-MARKET STATUS OF POPULATION IN RURAL, URBAN, AND METROPOLITAN COUNTIES*
APRIL–MAY 1940
(Percentage Estimates)

Urbanization group and month	Total population	Labor force			Non-workers
		Total	Employed	Unemployed	
United States					
April	100.0	41.8	34.9	6.9	58.2
May	100.0	42.4	35.9	6.5	57.6
Rural counties†					
April	100.0	37.7	32.0	5.7	62.3
May	100.0	40.3	35.4	4.9	59.7
Urban counties‡					
April	100.0	43.0	35.8	7.2	57.0
May	100.0	42.9	35.8	7.1	57.1
Metropolitan counties§					
April	100.0	47.9	39.5	8.4	52.1
May	100.0	46.3	37.6	8.7	53.7

Source: WPA Monthly Report of Unemployment.

* Figures subject to revision.

† Sample counties with a population of less than 45,000 in 1940.

‡ Sample counties with a population of 45,000 or more in 1940, excluding counties containing the 5 largest cities.

§ Counties containing the 5 largest cities: New York, Chicago, Philadelphia, Detroit, Los Angeles.

In the Nation as a whole employment increased between April and May, the labor force increased somewhat less, and unemployment declined. The so-called rural counties were entirely responsible for these changes (see Table II). In the rural counties employment rose very sharply, the labor force increased somewhat less rapidly, and unemployment decreased markedly. The situation in the metropolitan counties was exactly reversed; employment declined sharply, the labor force decreased by a smaller amount, and unemployment rose. The "urban" group of counties showed little change during the period either in employment, labor supply, or unemployment.

The changes in different geographic areas often are similarly diverse. The breakdown of national totals to show broad regional and urban-rural changes, age and sex shifts in the labor force, and changes in major industrial and occupational groupings provides a rich field for further experimentation and analysis of survey findings.

Thus far the movements discussed have all been net changes. These are the combined results of considerably greater numbers of changes in status on the part of individuals. Preliminary tabulations of survey data for the months of March and April, months in which identical households and persons were canvassed, serve to throw some light on the magnitude and direction of these shifts. The months selected were, on the whole, months of moderate change; they do not represent a period of extreme fluctuation.

Change of status during the two months has been measured in a forward direction, that is, in terms of the status in April of persons who had a specified labor-market status in March. The shifts reported are probably somewhat understated, since only persons who were in the sample during both months are included and since status was compared only for the two weeks of survey, thus failing to record a change for persons who changed status and then changed back between the March and April enumerations.

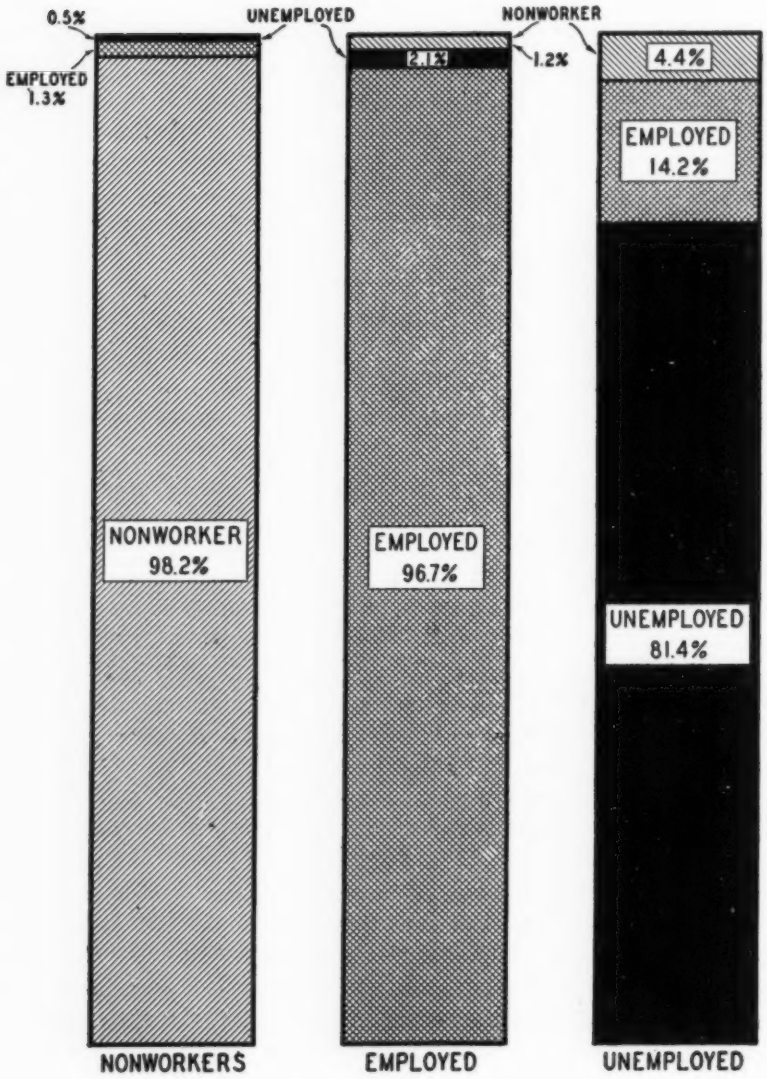
As Chart II and Table III indicate, 2 per cent of the nonworkers and more than 3 per cent of the employed group showed a change in status between March and April, while 19 per cent of the unemployed group reported such a change. In other words, about 1.4 million of the March nonworkers, 1.5 million of the employed, and 1.8 million of the unemployed changed their labor-market status during a period of 30 days. Although generalizations from a single pair of months are dangerous these figures do contain some interesting suggestions as to changes that take place in the labor force.

The 1.4 million nonworkers who had changed status by April had, of course, entered the labor market. As a very large part of the nonworker group is made up of children, housewives, and retired persons, it is surprising to find as much shift into the labor market during a single month as was reported. The figures suggest that the movement back and forth between worker and nonworker status is much larger than has been suspected. It is interesting to note also that approximately a million of the group which changed status went directly to employment; the remainder shifted to the status of unemployed.

Of the 1.5 million workers who were employed in March but had changed status by April nearly a million became unemployed. The remainder dropped out of the labor market.

CHART II

CHANGES IN LABOR-MARKET STATUS OF IDENTICAL PERSONS
MARCH–APRIL 1940
(Percentage Estimates)



Source: WPA Monthly Report of Unemployment

TABLE III

CHANGES IN LABOR-MARKET STATUS OF IDENTICAL PERSONS*
MARCH–APRIL 1940
(Percentage Estimates)

Status in March	Total	Status in April		
		Employed	Unemployed	Nonworker
Employed	100.0	96.7	2.1	1.2
Unemployed	100.0	14.2	81.4	4.4
Nonworker	100.0	1.3	0.5	98.2

Source: WPA Monthly Report of Unemployment.
* Figures subject to revision.

The most striking changes were reported for the unemployed group. Fully 1.8 million of the March unemployed changed their labor-market status during the month. It is encouraging that more than 1.4 million of these workers, or three-fourths of the total who changed status, had secured jobs. The remaining unemployed had left the labor market by April.

The data thus far presented all demonstrate that the labor force possesses a high degree of fluidity during short-run periods. It is apparent that seasonal changes in the size of the labor force are of the order of several millions of workers and that these fluctuations are the net result of a considerably larger number of shifts of status on the part of individuals. It seems clear that during the course of a year a much larger number of persons have been in the labor force than are employed or unemployed at any one period of time, and that there are large numbers who work or seek work during parts of the year and withdraw from the market at other periods.

Exact statement of the causes of these shifts must wait upon a great deal of further analysis. It is clear that one important cause is the closing of schools during the summer months, resulting in both permanent and temporary additions to the labor supply. Other shifts are caused by illness or accident, desire for retirement, changes in family income or family responsibilities, desire for further education, and so on. The decision of many persons to enter or leave the labor force probably is based largely on their judgments as to their market prospects—their chances of getting a job or of reemployment once a job has been lost, and the wages they may expect to receive. Some of these causes are pretty clearly seasonal in nature, others are probably related to cyclical fluctuations in economic activity, and some appear to be irregular in their influence.

There has been a great deal of discussion during recent years of the so-called "forced entries" to the labor market caused by the loss or dim-

inution of family income during the depression. Some such movement has undoubtedly taken place, but, as the foregoing discussion indicates, the net fluctuations in the labor force cannot be so simply explained. The factors which stimulate or delay entry to or exit from the market are extremely complex; a change in economic conditions which causes the entry of some workers into the market may cause the abstention or withdrawal of others. It appears that the total labor force tends, on the whole, to increase with both boom and depression conditions and to shrink in more normal periods, but available data do not provide a satisfactory basis for measuring the magnitude or timing of these movements.

In view of the surprising flexibility of the labor supply, and its tendency to expand and contract in accordance with demand, it seems probable that the sharp increases in employment forecast for the next year or so as a result of the development of the defense program will be accompanied by a considerable net increase in the active labor supply. Better employment opportunities and higher money wages should bring into the market considerable numbers of youth who have continued in school because they could not get a job, together with large numbers of out-of-school youth now dammed up on the farms because of the difficulty of obtaining employment in the cities. It appears probable, further, that many seasonal workers will remain in the market after their usual period of activity with the expectation of securing additional employment. In the short run, at least, these and other groups stimulated to enter or remain in the market should considerably more than offset the withdrawal of groups for whom better times provide an opportunity to leave the market and engage in other activities.

The normal net addition to the labor force is generally estimated at about 600,000 workers per year. This figure represents the excess of youth arriving at working age over estimated normal withdrawals from the labor force due to death or advancing age. It should not be surprising if the pull of better times coupled with the push of a near-war psychology results in an additional net influx to the market of several millions of workers during the next two or three years, over and above the normal growth. The scant evidence available suggests that an extremely rapid rate of influx occurred during the first World War.

It follows that caution should be exercised in translating estimates of probable increases in employment into estimates of probable future decreases in unemployment. The marked employment gains which are in prospect may well be offset in considerable part by sharp gains in the total supply of labor offered in the market.

WHOLESALE PRICE INDEXES*

By Francis McIntyre, *Indiana University*

The trend in price indexes is toward fewer such indexes, rather than more. Once it was fashionable for many firms to construct price indexes. Today the field is dominated not by the indexes of any private agency, but by a single index, prepared by a government bureau.

Why has this change come about? Largely through the improvement of index number technique. Lest that seem paradoxical, an explanation is in order. While index number formulas were of extremely simple pattern, and unweighted indexes were the rule rather than the exception, almost any enterprise could, at small expense, indulge itself in the luxury of maintaining its own index number, much as some financial institutions in the golden era kept economists.

Since Irving Fisher's impressive summary[1] of index number formulas a decade and a half ago there has been increasing emphasis on "good" and "bad" weighting systems. The opprobrium cast upon totally unweighted index numbers became too much to bear, and many have made a quiet exit from regular publication. Among those remaining the tradition for the Laspeyres formula became so strong that the only excuse for the competitive production of index numbers became a preference for a differing list of commodities (even the selection of weights seemed to be by acclamation) and others fell by the wayside.

In recent months we may have been witnessing the manifestation of another source of index number mortality—the lessened prosperity of financial publications. If the business of trading in the security markets is really as unattractive as recent quotations on exchange seats would indicate, many of the valuable services which the statistical departments of these publications have performed in the past are likely not to be available to the economist in the near future. Surely each of us shed a sincere academic tear at the passing of the well-remembered *Annalist*. We must be prepared for similar bereavements in the future.

The increasing dependence on governmental agencies as a source of published index numbers which the above-mentioned developments imply is not here viewed with alarm. The *raison d'être* of index numbers is surely the service they perform for a community of economists, in a very broad sense of that much abused term. It simply seems appropriate in this connnection to note the source of supply.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

[1] Irving Fisher, *The Making of Index Numbers*, (Houghton Mifflin Co., New York, 1927, 3rd Edition).

Important non-governmental general index numbers of wholesale prices of course continue. A by-no-means exhaustive list must include the weekly series of The National Fertilizer Association, the Babson Institute, the Index Number Institute, and the Journal of Commerce, as well as the daily series of Dun and Bradstreet and the Journal of Commerce. But the daily, weekly, and monthly indexes of the Bureau of Labor Statistics continue to be predominant, and in the remainder of this paper major attention will be paid them.

The daily BLS index is relatively new. Its reporting was begun only last year, and it is based on August 1939. Twenty-eight "sensitive" commodities are used, and an unweighted geometric mean of the price quotations is the index obtained. Released for publication weekly, this index is available daily by telephone or telegraph. While one is pleased to see the increased use of the geometric mean for such purposes, especially where weighting is believed to be impractical, this daily index is not a major product of the BLS statistical mill, and our discussions of formula and content should concern the much more extensive weekly and monthly series.

It is difficult to keep up with the number of price series the BLS index employs. Over quite an extended period of the 1930's it was about 784. A recent report mentioned 813. This is subject to change on necessarily short notice. It is difficult to know why so many series are used. The index has probably gained little in accuracy as a sample of all wholesale prices, merely by approximating a census of those commodities for which regular quotations are available. It is evident that sensitivity is not an objective, but merely in the interests of not exhausting the statistical facilities of the Bureau, some better criteria ought to be developed of how far it pays to push the inclusion of new price series beyond the point of diminishing returns.

A change in the method of construction of the BLS wholesale price index[2] took place about three years ago, which change was of much greater moment than any increase in the number of series. This is the abandonment, largely on the grounds of expediency, of the chain index method for the fixed base, variable multiplier technique.

The old method employed this formula:

$$I_i = \frac{\sum p_i q_w}{\sum p_{i-1} q_w} \times I_{i-1}$$

[2] Jesse M. Cutts and Samuel J. Dennis, "Revised Method of Calculation of the B.L.S. Wholesale Price Index," this JOURNAL, Vol. 32, No. 200 (December 1937) pp. 663–674.

where I is the index, i stands for any period, and w the period from which weights were obtained. With this formula a new series is added or an old one withdrawn by making the numerator and denominator of each link always include identical series. Thus for each month (say) there may be two aggregates. One will give the total of values appropriate to the preceding month, the other to the following month. The author has suggested elsewhere[3] that a commodity might be called *effective* in any month if its price for that month is permitted to affect the index for that month. Then each link may be written $L_i = \frac{\sum_i p_i q_w}{\sum_i p_{i-1} q_w}$ where both summations are taken over all and only over the list of commodities effective in period i. This process of keeping numerator and denominator of each link comparable is the only "correction" necessary when series are added or withdrawn. It would appear extremely simple, yet is objected to on the following grounds:[4] (1) Aggregates are not comparable over an extended period. This makes difficult the combining of price series into new groups. Since such combinations are frequently needed, the clerical work is heavy. (2) When a new price series is introduced under an old name (e.g., a change in the specifications of the article, but not in its common name) the old quantity weight yields a meaningless product. (The implicit assumption that the old quantity weight must be retained is not defended.) (3) The price multiplied by the quantity weight may give a meaningless product even without a substitution.

The second and third of these points may, it seems, be dismissed without much discussion. It may appear awkward or inconvenient to regard each change in a price series as the substitution of a new commodity for an old one, yet this is perhaps the only procedure certain to place in sharp relief the significance of altering the precise description of the commodity whose price quotation is employed.

There remains then the alleged difficulty of recombining the several commodities into different groups from those originally contemplated or constructed. That this may have presented a problem at some time in the past is of course possible, but modern statistical machinery would appear to reduce this operation to extreme simplicity. Presumably the price quotation is punched in one field of an electric accounting machine card, the appropriate quantity weight is punched in another, and the

[3] "The Problem of the Stock Price Index Number," this JOURNAL, Vol. 33, No. 203 (September 1938) pp. 557–563.

[4] Cutts and Dennis, *op. cit.*, pp. 665–666.

extension of their product is obtained electrically in a third field by means of a multiplying punch. If the desire to include differing grades or specifications under the same commodity name is irresistible, fourth and fifth fields may be used for price and quantity adjustments;[5] the sixth field should then display the original product (field three) plus or minus the product of fields four and five. This too is a simple automatic cross-footing operation for the multiplying punch.

Then when all the cards for month i are sorted together, the total of field three will be the denominator of L_{i+1}, the total of field six the numerator of L_i. A new commodity will have a blank field six on first appearance; a withdrawn commodity will have a blank field three on last appearance. Let us consider an example:[6]

Commodity: Currants. (No. 247)
Old series: Amalia variety. December 1936 price 11.0¢/lb.
Quantity weight 8215 (presumably the total
1935 marketings of currants in M lbs.)
New Series: Patras variety. December 1936 price 11.5¢/lb.

Now 8215 is justifiable only if 11.0×8215 makes sense for December 1936; i.e., if that product is the value of (say) 1935 marketings at December 1936 prices. If this is not the case, no selection of formula will help matters. This is a question of the validity of using Amalia currant prices as an average price for all currants, and has nothing to do with the appropriate correction for change to Patras currants.

The December 1936 card should then look like this:

			Field Numbers					
			#1	#2	#3	#4	#5	#6
1936	12	247	11.5	7858	90365.0	—	—	90365.0

and 7858 $\left(=\frac{11.0}{11.5} \times 8215\right)$ is the correct quantity weight until the next census. If, however, the substitution is made on the grounds that the Patras price is a better average than the Amalia for use in association with the quantity weight of 8215, this substitution should be handled as follows:

			#1	#2	#3	#4	#5	#6
1936	12	247	11.5	8215	94472.5	0.5	8215	90365.0

In neither case is the index for December 1936 affected.

[5] A simple adjustment procedure is illustrated below.
[6] Taken from Cutts and Dennis, *op. cit.*, p. 667.

To construct any desired new index it is necessary only to designate by code number the commodities one wishes to include, permit the collator to select those commodities whenever they appear in the cards for each month, and tabulate fields three and six for these cards, controlling on the month. The only clerical work required is a division to express each field six total as a ratio to the field three total for the previous month, and a chaining of these links by product cumulation.

The "improved" formula of the BLS index is a fixed base aggregative, $I = \frac{\sum p_i q'_w}{\sum p_0 q_w}$ in which the denominator is left alone, and compensating adjustments in q' are made whenever a correction must be applied to a price series. That this yields aggregates $p_i q'_w$ having no value significance is recognized, but not regarded as of importance. At this point I wish to register a sharp difference of opinion. I prefer what seems to me the simpler chain method on two grounds: Not only is it simpler, but it provides aggregates of price × quantity which are currently meaningful. Note that the final numerical results of the index computation are not at issue. I have shown elsewhere[7] that a systematic treatment of the corrections under the two methods will yield identical final index numbers.

One final remark needs to be made on the relation of index number theory to economic theory. Except for the field of price of living index numbers, and perhaps that of stock price index numbers, this relationship remains almost unexamined. The noteworthy exception in the case of price of living is due to a series of articles beginning in the *Review of Economic Studies* in 1935, and continuing through the literature for several years. The position was there developed that the problem of changing patterns of consumption and different lists of commodities at different dates would be solved if the commodities and weights were so selected that equal index numbers at different times indicated the individual still to be on the same consumption indifference curve, despite the changed composition of his market basket.

Now wholesale prices as a mass are so heterogeneous that I see no possibility of a parallel development, but there is a restricted class of prices for which theoretical tools are ready and waiting. These prices are the costs to producers of the factors of production, and the tools are the isoquants of the theory of production, as developed by Schnei-

[7] Alfred Cowles and Associates, *Common Stock Indexes 1871–1937*, (Principia Press, Bloomington, Indiana, 1938) pp. 25–30.

der, Carlson, and others.[8] An isoquant is the locus of factor combinations yielding a constant output. An index of production costs would be comparable at different periods if the commodities and weights were so selected that identical index numbers indicated the producer still to be on the same isoquant, despite the changed composition of his factor input.

The practical issue here is of course the need for the inclusion of services along with commodities in the price index. This lack is more serious than the objection (made against any proposed index of production costs) that every industry—even every plant—would require a separate index with a specialized list of commodities, services, and weights. Further, it must be emphasized that no criticism is due the Bureau of Labor Statistics because such an index happens not to be available. It is not supposed that the name "wholesale commodity prices" ought to be stretched to include productive services.

This is a problem not completely dissociated from current defense needs. With the cost of production looming more important daily, further study of it is essential. While the range of available production techniques may be quite different in different industries, variety is surely not as great as in consumption patterns,and a production cost index meeting these requirements for (say) heavy industry as a class ought not be entirely unyielding under the impact of this type of analysis.

[8] See especially Sune Carlson, *Studies in the Pure Theory of Production*, (P. S. King, London, 1939).

COST OF LIVING INDEXES*

By Robert A. Sayre
National Industrial Conference Board

In analyzing cost of living indexes it would seem most feasible to limit the analysis to a brief discussion of time-to-time indexes, i.e., indexes which measure changes in living costs from one period of time to another but do not measure differences in living costs between one place and another place. The two oldest and best-known national indexes, which have been available continuously over a long period of time, are the indexes prepared and published by the United States Bureau of Labor Statistics and the National Industrial Conference Board. The first to be made available for the United States was that of the Conference Board in 1918[1] and it was carried backward for selected dates to July, 1914; followed by that of the Bureau in 1919[2] which was extended backward to 1913.

Numerous changes have been made in the context, coverage, and publication dates of these indexes. The situation today is this: The Bureau publishes for each quarter indexes for the United States and 34 specified cities, Milwaukee having been added to these surveys in December, and preliminary interim indexes for each month beginning with October for the large cities of the United States and 20 of these cities at the request of the National Defense Commission.[3] The Bureau will shortly release quarterly indexes for 20 small cities and for cities with special problems arising out of the Defense Program and indexes of rents in Defense cities, also at the request of the Commission. The Conference Board publishes each month indexes for the United States and 56 specified cities.[4]

The Bureau has recently revised its indexes from 1935 to date[5] and has placed them on a 1935–1939 = 100 base in line with the recommendations of the Central Statistical Board. The indexes for earlier years were linked to the new series, taking the new major budget group weights into consideration in the linking process since 1925.[6] Now, the

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

[1] "Wartime Changes in the Cost of Living," National Industrial Conference Board, *Research Report No. 9*, August 1918.

[2] Hugh S. Hanna, "Summary of Increased Cost of Living, July, 1914, to June, 1919," U. S. Bureau of Labor Statistics, *Monthly Labor Review*, October 1919, p. 7.

[3] *Monthly Labor Review* and press releases.

[4] *The Conference Board Economic Record.*

[5] Prepared by Cost of Living Division, Dr. F. M. Williams, Chief, "The Bureau of Labor Statistics' New Index of Cost of Living," *Monthly Labor Review*, August 1940, pp. 367–404.

[6] *Ibid.*, pp. 392–404.

Conference Board index for the United States is on a 1923 = 100 base but is in the process of revision and shortly will be related to a more recent base period. Its indexes for 56 cities are on a January 1939 = 100 base. The two indexes for the United States are compared in Chart I.

CHART I
COST OF LIVING INDEXES
UNITED STATES, 1913–1940

That of the Bureau represents the new index since 1935 with the old index linked on for earlier years. All these indexes are compiled, in a sense, by the aggregative method. Under this method, all the items purchased by families of wage earners and lower-salaried clerical workers would be priced each period and the aggregate cost would then be related to the aggregate cost in the base period to obtain the index. Actually, however, the procedures followed are different. These differences will be discussed only briefly since they are merely expedients nec-

essary to make the aggregative method more flexible. They provide for sampling rather than for complete coverage and for changes in the sample of reporters and of items priced.

Both agencies report indexes for a similar number of categories of purchases, namely, all items, food, housing, clothing, fuel and light, housefurnishings, and sundries. The exception is that the Conference Board index includes housefurnishings under sundries. When revised, this index will also show housefurnishings separately.

The various steps involved in the compilation of the indexes are complex and involve many refinements of method. They do, however, spring from certain basically simple concepts. In each period, both organizations collect from retailers throughout the country retail prices of a long list of commodities. The method of collection, of course, varies. Through its retail price division, the Bureau sends field workers to the 34 cities and depends upon these workers to collect nearly all of the prices which go into its indexes. The Conference Board collects the major portion of its prices by the questionnaire method. In other words, questionnaires are mailed to retailers in nearly 200 cities, who in turn record prices on them and send them back to the Conference Board. While the Bureau covers the complete list of selected budgetary items in each of the 34 cities, the Conference Board does not cover all selected items in all of the nearly 200 cities. It does, however, cover all selected items in 70 cities, for 56 of which it publishes city indexes.

Since the two organizations compile their city indexes by somewhat similar methods, they will be discussed first and the United States indexes later. This mass of retail prices is assembled by cities by budgetary groups. Prices of individual items in a city are then averaged in any given month. From this point on, the compilations follow different paths, reaching, however, the same end. The Bureau calculates the percentage changes in these average prices from those in the previous period, using an identical sample of items and outlets, and applies them to the estimated costs of each item in the previous period to obtain costs in the current period. A grand total and totals by budgetary groups are computed. These totals are related to the totals in the base period to obtain the indexes. Under this procedure, the Bureau applies price ratios to basic expenditures by wage earners and lower-salaried clerical workers to secure cost aggregates for each pricing period.

On the other hand, the Conference Board compiles the average prices of the individual items for two successive months from identical establishments. These prices are weighted by the typical quantities purchased and aggregated by budgetary groups. Thus data are obtained for a pair of months from an identical sample. The change in this sam-

ple from the preceding month to the current month is then applied to the index for the preceding month to obtain the index for the current month. The resultant group indexes are weighted by a percentage distribution indicative of typical purchasing, to obtain the total cost of living.

The weighting systems employed are derived from the annual purchasing habits of consumers representative of the city for which the index is constructed. In other words, different weights are used for different cities. Thus, if the cost of living rises 1 per cent in Boston and 2 per cent in New York, it does not mean that the same commodities rose more in price in New York than in Boston, but that the cost of commodities usually purchased each year in New York rose more than those usually purchased each year in Boston.

These weights were derived from recent studies of the annual purchasing habits of actual consumers—that is, families of wage earners and lower-salaried clerical workers—in many cities. The most recent and comprehensive studies of this type are the *Money Disbursements of Wage Earners and Clerical Workers* and the *Studies of Consumer Purchases, Urban Series*, conducted by the Bureau of Labor Statistics with the assistance of the Works Progress Administration during the period 1933–1936.[7]

Turning now to the United States indexes, that compiled by the Bureau is a composite of its city indexes weighted in accordance with the population of the metropolitan area of each city plus adjacent metropolitan areas and cities having over 50,000 population in the same region considered to be subject to similar price movements.[8] The Conference Board index for the country as a whole is compiled directly from the Bureau's index of retail food costs and from the retail prices of other items collected by the Board and does not as yet employ weighting factors based upon the new budgetary studies.[9] When the revision of this United States index is completed, however, it will be a composite of city indexes and will continue to take into consideration data collected from the other cities for which no city indexes are now being published. Likewise, the new composite of city indexes will be weighted on the basis of population. Preliminary calculations reveal that the Conference Board's revised index, like the Bureau's, will show no marked variation from the old index.

[7] Faith M. Williams and Alice C. Hanson, *Money Disbursements of Wage Earners and Clerical Workers*, U. S. Bureau of Labor Statistics, Bulletins Nos. 636, 637, Vols. I and II, 639, and 641; A. D. H. Kaplan, Faith M. Williams, and Mildred Hartsough, *Study of Consumer Purchases, Urban Series*, U. S. Bureau of Labor Statistics, in cooperation with Works Progress Administration, Bulletins Nos. 642, Vol. II; 643, Vol. II; 646, Vol. II; 647, Vol. II; and 648, Vols. II, V, and VI.

[8] *Monthly Labor Review*, August 1940, *op. cit.*, pp. 386–388; and September 1935, pp. 828–830.

[9] National Industrial Conference Board, *Cost of Living in the United States, 1914–1936*, pp. 13–42.

Digressing for a moment, attention should be called to a source of misinformation about the Conference Board's index for the United States. The *Encyclopaedia of the Social Sciences* in an article on the cost of living by Dorothy W. Douglas[10] discusses the construction of the Conference Board index. This material was copyrighted in 1930, and, at the time of publication, was correct; but within a few months it was incorrect because of revisions made in the index.[11] No changes have been made in this article; all reprints of the *Encyclopaedia* have apparently been made from the original plates. This merely indicates the difficulties which may arise from using secondary source material.

So much for the construction and coverage of these indexes. The last two points to consider are their usefulness and improvements which might be made in them.

To my mind, cost of living indexes perform a threefold task:

1. They measure changes in the cost of living.
2. They show changes in purchasing power.
3. They are useful in determining time-to-time changes in wage or salary levels, but not place-to-place changes.

The indexes of the Bureau of Labor Statistics and the National Industrial Conference Board, as indicated by the methods used in their construction, do measure changes in the cost of annual living in any given period of time for a workingman and his family and for a lower-salaried clerical worker and his family. Typical purchasing by this group is the basis of the indexes. These indexes do not measure changes in the cost of living for those in higher income brackets and should not be considered to do so. True, costs for all people tend to move in the same general direction over long periods. It is probably reasonable to say that, if these indexes rose 15 per cent in X years, the chances are that living costs of people in the $10,000 income class, or any other, likewise rose appreciably. The inclination, however, to apply month-to-month movements in the indexes to people for whom they were not intended could conceivably lead to false conclusions. For example, on numerous occasions, living costs rise or fall principally because of changes in food prices, other items in the budget remaining relatively stable. Of course, food costs are a considerably smaller proportion of the expenditures of the higher income recipients and, hence, even if the foods purchased by these people rose by the same percentage as those purchased by the wage earner and lower-salaried clerical worker, the increase in total living costs would be appreciably smaller. Indeed, the increase which

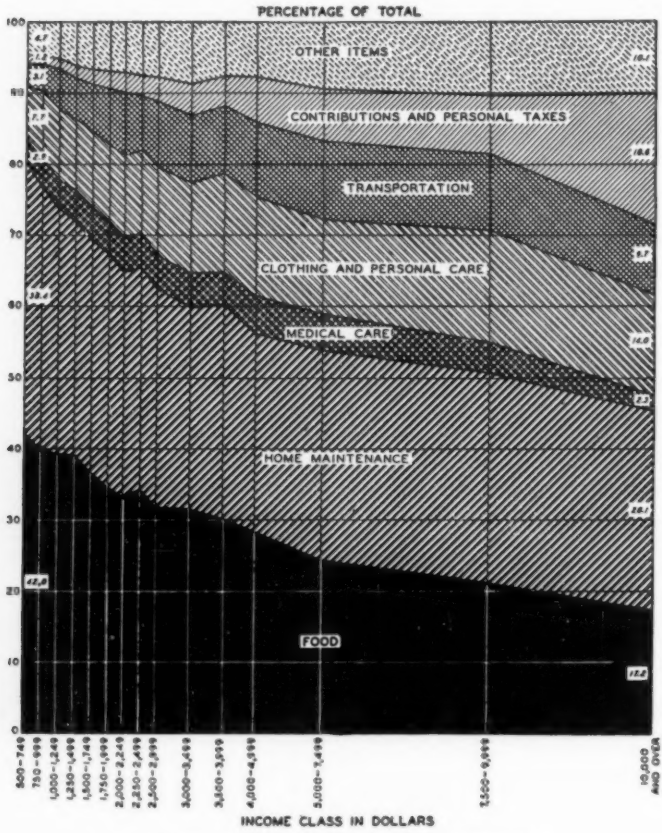
[10] Dorothy W. Douglas, "Cost of Living," *Encyclopaedia of the Social Sciences* Reissue of November 1937, Volume II, pp. 478–483.

[11] National Industrial Conference Board, *Cost of Living in the United States*, 1914–1930, pp. 35–43.

seemed large on the basis of the indexes might actually be so small, when weighted in accordance with their importance in the budget, for the other group as to have virtually no significance.

CHART II

DISTRIBUTION OF MONEY EXPENDITURES FOR FAMILY LIVING
CHICAGO, 1935–1936



Source: "Family Expenditure in Chicago, 1935–1936,"
Study of Consumer Purchases, Urban Series,
Bureau of Labor Statistics-Works Progress Administration

As indicated in Chart II, the consumer purchases study for Chicago[12] shows, for example, that in 1935–1936 food accounted for 42 per cent of the expenditures of $500–$749 income class but for only 17 per cent

[12] A. D. H. Kaplan, Faith M. Williams, and Mildred Hartsough, *Family Income and Expenditure in Chicago, 1935–1936, Volume II, Family Expenditure*, U. S. Bureau of Labor Statistics, in cooperation with Works Progress Administration, Bulletin No. 642, Vol. II, p. 11.

of those of the $10,000 and over income class. Similarly compared, clothing and personal care rose from 8 to 14 per cent, contributions and personal taxes from 1 to 19 per cent, and miscellaneous items from 5 to 10 per cent. Home maintenance, on the other hand, dropped from 38 to 28 per cent between the two income levels.

Perhaps the most evident reason against using these indexes outside their field is that the higher the income the more diversified the spending habits. Hence, the less typical any index becomes. When income is relatively low, people are limited in the variety of things they can do with their money because they must first eat, have shelter, and be clothed. In contrast, higher income brackets spend a much smaller proportion of their incomes for these necessities, and considerable amounts for optional items. Out of total estimated expenditures in 1937 of 71 billion dollars, 54 billion went for ordinary items and only 17 billion for luxuries.[13] When you consider that these data include spending by all the people, you can readily understand that the luxury segment would rapidly shrink if the estimates were confined to the wage-earner-lower-salaried-clerical group. A comparison of optional spending with subsistence spending between 1909 and 1937[14] reveals that, despite the fact that optional spending has grown over the years, in 1937 only 56 per cent of per capita expenditures by all the people represented reasonably free exercise of choice; 44 per cent was necessary for subsistence. Similarly, if these figures were confined to the lower-income workers, the percentage of subsistence spending would be considerably augmented. The standard of living of wage earners' families has improved over the years as indicated by available budgetary studies.[15] In 1869–1879, food absorbed over 51 per cent of the expenditures of these people while miscellaneous items accounted for only 11 per cent. In contrast, by 1930–1935, food had dropped to 33 per cent and miscellaneous items had risen to 35 per cent.

The second task of cost of living indexes, measuring changes in purchasing power, is quite easy. The purchasing value of the dollar is simply the reciprocal of living costs. If living costs rise, it follows that the purchasing value of the dollar declines. If the desire is to measure changes in the purchasing power of a particular wage group, sometimes referred to as "real" wages, the wages can readily be divided by the cost of living index to eliminate the influence of changes in these costs. Chart III compares annual data of the Conference Board's indexes of the cost

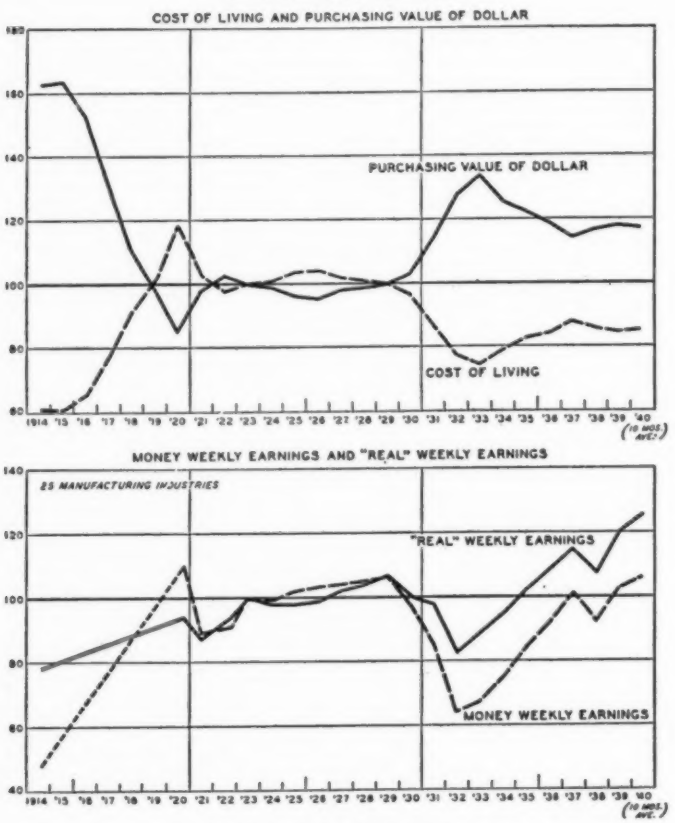
[13] National Industrial Conference Board, *Road Maps of Industry*, No. 235, June 28, 1940.
[14] Derived from *Conference Board Studies in Enterprise and Social Progress*, pp. 139, 144, 147.
[15] *Ibid.*, p. 153.

of living and of the purchasing value of the dollar from 1914 to date. The chart compares money weekly earnings with "real" weekly earnings in 25 manufacturing industries,[16] i.e., money weekly earnings adjusted for changes in living costs.

CHART III

PURCHASING VALUE OF DOLLAR AND OF WAGES
UNITED STATES, 1914–1940

Index Numbers, 1923 = 100


COST OF LIVING AND PURCHASING VALUE OF DOLLAR
PURCHASING VALUE OF DOLLAR
COST OF LIVING
MONEY WEEKLY EARNINGS AND "REAL" WEEKLY EARNINGS
25 MANUFACTURING INDUSTRIES
"REAL" WEEKLY EARNINGS
MONEY WEEKLY EARNINGS

Source: The Conference Board

The third and last task involves the use of these indexes in determining wages or salaries. They are useful in making changes in wages or salaries from time to time within a group. If you assume that the wage level today for machinists or shipping clerks, for example, is correct, changes in the indexes may be considered as one measure of when wage

[16] National Industrial Conference Board, *Wages, Hours, and Employment in the United States, 1914–1936*, and subsequent publications.

or salary adjustments may become necessary for these workers. If the cost of living rises 5 per cent, it may be desirable to raise machinists' wages 5 per cent. Indeed, there are union contracts in force today which specify that a fixed percentage change in living costs will be accompanied by a fixed change in wages.

What has been said so far might seem to indicate that these indexes are performing their function and are above reproach. This is not quite true. I believe that they suffer from two important weaknesses, one of which is more apparent than real, and the other of which does not lend itself to correction.

The first is the infrequency with which budgetary studies are conducted. Prior to the 1933–1936 Money Disbursements and Consumer Purchase Studies of the Bureau of Labor Statistics and the Works Progress Administration, and since 1918, only a few investigations of purchasing habits of consumers were made. Such a survey in 1918–1919,[17] made by the Bureau, was used until recently by it to determine weights and to select commodities for pricing. Other surveys conducted in the period 1921–1929 were used by the Conference Board[18] as the basis for the revision of its index made in 1931 and carried back to 1914. It is quite true that these earlier studies became definitely out-of-date but continued to be the basis of the indexes until recent months. You are, of course, familiar with the revisions in the Bureau's indexes which have been published. Details of those in the Conference Board indexes have not been completed and, hence, have not been published. As might be expected, the Bureau's new indexes differ only slightly from the old indexes.

I feel, therefore, that although new budgetary studies result in little change in the indexes, they should be made frequently, say every five years, and certainly not less frequently than every ten years, since they provide the basis for corrections in weights and in items priced. In this way doubts as to the accuracy of the basis of the indexes will be eliminated. Infrequent studies cause such doubts to rise and to magnify in the minds of persons interested in changes in living costs. There is no other way to dispel these doubts than to prove by actual surveys and calculations that the indexes are representative. Unfortunately, however, complete budgetary studies are exceedingly expensive. Until new and less costly methods are devised it is improbable that comprehensive studies will be made as frequently as they should be.

The other principal weakness lies in the fact that at each period the indexes measure changes in the cost of annual living. Such procedure

[17] *Cost of Living in the United States*, U.S. Bureau of Labor Statistics, Bulletin No. 357, May 1924.
[18] National Industrial Conference Board, *Cost of Living in the United States, 1914–1936*, p. 42.

fails to account for variations in purchasing habits due to the effects of the season, or shifts in the season, and to unusual conditions. Imputed annual consumption of fresh green beans by families of wage earners and lower-salaried clerical workers in this country is about 9 pounds.[19] But, fresh green beans are expensive in winter and inexpensive in summer. By imputation, about 80 pounds of onions are consumed each year.[20] They appreciate in the winter much less than fresh green beans since they can be readily stored. Hence, it is reasonable to suppose that a large proportion of the annual consumption of fresh green beans is purchased in the growing season and that the major portion of the annual purchase of onions occurs in the winter months when they are relatively cheap. Likewise, electricity is used in varying amounts in the different seasons. You might say, find out seasonal purchasing habits and shift the weights in your index to allow for this. In conducting the Money Disbursements Studies, the Bureau of Labor Statistics did study food purchasing habits in a typical week for each of the four seasons.[21] It would seem that here at least would exist a basis for eliminating the effects of the season. But it would also introduce a heavily weighted factor of seasonal shift. Suppose that spring is late and a drought is severe in the truck crop belt. Fresh green beans would be scarce and expensive. But we would be assuming that purchasing would be the same as if spring had come at the usual time and there had been no severe drought. Introduction of seasonal weights would, therefore, eliminate one difficulty and introduce another just as important. Price changes because of accidental happenings would distort any index, be it on an annual or on a seasonal basis. In other words, there seems to be no way to make allowance for changes in purchasing habits caused by fluctuating prices. Too many factors influence price, most of which cannot be measured with accuracy on a quantity basis.

In conclusion, I believe that the cost of living indexes prepared by the Bureau of Labor Statistics and by the Conference Board are good indexes, so long as it is understood that they measure time-to-time changes in prices of annual purchases, and their use is confined to the economic groups whose living costs they were intended to measure. They would be improved by more frequent budgetary studies; and by the use of seasonal weighting systems if these were feasible.

[19] Stella Stewart, Chief, Retail Price Division, and Faith M. Williams, Chief, Cost of Living Division, *Retail Prices of Food, 1923–1936*, U. S. Bureau of Labor Statistics, Bulletin No. 635, Table G, pp. 182–183.

[20] *Idem.*

[21] "Money Disbursements of Wage Earners and Clerical Workers," any bulletin in this series, Appendix F.

PRICE INDEXES AS VIEWED FROM THE STANDPOINT OF THE NATIONAL DEFENSE PROGRAM*

By Martin Taitel, *Economic Consultant, Price Stabilization Division, National Defense Advisory Commission*

The most vivid pictures of our economy during the World War period are those of the price-profit-wage spiral of inflation. These pictures have, in the main, been drawn in terms of price movements largely because there is a greater abundance of data on prices for that period than on profits, wages, production, and so on.

So dramatically have the evils attendant upon the spiraling of incomes and values been painted in terms of prices that in some quarters the tendency has developed to consider the abolition of price increases as the goal of price policy. The schematic outline of the thought process is something like this: (1) the evils of inflation must be avoided, (2) price increases give rise to inflation, (3) the elimination of price increases will prevent the evils, (4) ergo, prices must not be permitted to increase.

When the attitude toward economic problems is that the goal is rigid prices, then the questions which bedevil the economist and statistician are: At what levels should prices be fixed? What indexes should be used as guides? Should there be attempts to stabilize a particular price index? If so, which one? If not, should the levels and relations between various indexes be fixed? These are the kind of questions upon which attention becomes focused when price control is considered to be the price job required by a defense program.

Clearly such an approach detaches prices from the myriad of other factors in market situations and places them in a realm of their own. Technology, costs, supplies, trade practices, geography, and so on are considered only at a later stage when the practical questions of when, how, and at what levels controls are to be invoked, have to be faced. But, by this time, the market factors other than price have become difficult or impossible to affect, so that either price fixing without regard to them is necessary or prices must be set at undesirable levels.

The whole approach to prices from the standpoint of price control is much too narrow because price control in and of itself does not provide the most important reference points which must be the guides to policy and action. The real perspective toward prices and price policies can only be obtained from a clear notion of what the job of national defense is.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

The national defense program is designed to achieve very concrete objectives. Primary among these is the expansion of production and productive power, not only in the area of military equipment and supplies, but also in the area of goods and services for the civilian population. Military requirements, of course, take precedence, but, to the extent that our productive power permits, output for civilian use is to be expanded. In short, the goal of the defense program is a vigorous efficient economy operating at high levels of production, both military and civil; and, of course, an economy organized and operated within the tenets of a democracy.

It is with reference to this conception of the national defense program that questions as to the use, adequacy, improvement, and development of price indexes have a relevant locus.

As far as the purely technical aspects of price index construction are concerned, the problems and considerations are the same when the indexes are to be used under a defense program as they are when the indexes are to be used under normal peace-time conditions. Of course, prices rather than price quotations are to be obtained; of course, items and weights most appropriate for the purpose in mind are to be used; and so on down the line of all those things which constitute a technician's nightmare in the price index field.

The use to which price indexes can be put under a defense program depends at heart upon the conception of the function of prices in the attainment of the objectives of the program—upon the attitudes and policies toward prices.

While the policies toward prices under the defense program have not as yet jelled, the broad outlines have been fairly clearly indicated. Broadly, the objectives are (1) to provide a reasonable degree of stability of price levels, (2) to provide for flexibility, down as well as up, of individual prices so long as such prices remain within bounds, and (3) to provide a balanced price structure or relationships between prices which are conducive to balanced and expanding flows of production from and incomes to the various groups in the economy. But these objectives are sought, not as ends in themselves but as the means to the real end—national defense.

Price structure and the broader movements of prices are considered as strategically important factors affecting both the level and the distribution of resource use. Prices are considered as major determinants of the income distribution and thereby of the pattern of expenditures which in turn determines not only the distribution of output but also the total output.

So far as the level of prices is concerned, the conception is that a reasonable degree of stability is essential for the orderly conduct of economic activities. The importance of price level stability has impressed itself upon the Nation so deeply that one can almost use interchangeably the statements of all groups in the economy from the most conservative to the most radical.

I quote here from a statement of one of the conservative groups, the United States Chamber of Commerce:

> Violent price fluctuations cause strains and dislocations in the country's economic processes and result in hardships for business, labor, and consumers.
>
> Thus, the long-term interests of everyone in prices are identical.
>
> In connection with the defense efforts of the government, business men have firmly and consistently declared their intention to do everything within their power to prevent price increases that may not be justified.

Within the price structure, of course, flexibility is desired—flexibility, that is, in the sense of ease of adjustment to fundamental changes in market conditions, but not in the sense of erratic and gyrating fluctuations in answer to speculative or even manipulative activities. Under conditions of accelerated production and of marked changes in the product-mix, all those factors which make price flexibility necessary in peace-time developments are accentuated. And this makes it even more important that prices be flexible during the present emergency than during other periods.

With respect to individual prices, to an audience of statisticians, one may best indicate the general attitude by saying that price is considered the dependent variable and not the strategic independent variable. And, consequently, attention is focused on the factors affecting price rather than upon price *per se*.

This attitude or approach is sharply different from that of the World War period. *Then* price was thought of as the prime mover of production and capacity expansion. A perusal of the minutes of the price-fixing committee of the World War period shows this quite clearly.

Under the present defense program, however, expansion of supply, production, and capacity are attained in large measure by working on factors other than price. Or, if expansion is impossible, either immediately or eventually, then techniques other than price changes are used to determine who gets the available supplies or output.

However, should these procedures fail of their purpose and should it seem likely that prices are about to start an upward spiral, it is quite

probable that more direct procedures will be used.[1] There seems to be no intention on the part of those in charge of the defense program to permit run-away price movements. While they are not desirous of using strong-arm methods, they are determined to attain their objectives in the price as well as in other areas.

The present attitude toward prices can best be illustrated by a few specific examples of the way in which the price problems arising in various sectors of the economy have been met.

Sugar. Import quotas were suspended and later restored—and this it may be noted occurred prior to the establishment of the Defense Commission.

Copper. Conferences were held to discuss probable requirements, supply, production, and capacity, to crystallize the nature and scope of the supply problem, and to canvass the possibilities for obtaining adequate supplies without price disturbances. The result of these conferences and of studies made by the Defense Commission indicated that a probable shortage of copper in 1941 could most satisfactorily be met by the importation of South American copper. Recently, as most of you no doubt noted, the Metals Reserve Company has contracted for 100,000 tons of such coppper. And, of course, careful study is being given to methods of expanding domestic capacity should this become necessary later.

Steel. The initial step was export control of certain grades of steel scrap. Later the export-licensing controls were extended to cover all scrap and some steel products as well. More recently arrangements have been made for the importation of coke from Britain. Furthermore, in steel—as in other areas—the Government stands ready to provide suitable financial guarantees in order to obtain expansion of facilities. And, finally, for the purpose of enhancing the steel scrap supply, certain reductions in freight rates on scrap have been proposed as a more desirable change in the price structure than further increases in scrap prices because excessive rises in scrap prices act as a lever on steel prices.

Lumber. This is a case in which prices have not behaved satisfactorily and in which prices are still at unreasonably high levels. Dissemination of market information was used in order that interested parties would be conversant with the fundamental underlying conditions. Recently Commissioner Henderson has pointed out that high lumber prices en-

[1] Since this paper was delivered, direct price controls have been applied in a few cases. As of April 5, maximum ("ceiling") prices have been established as follows: Second-hand Machine Tools (February 17, 1941); Aluminum Scrap and Secondary Aluminum Ingot (March 24, 1941); Zinc Scrap Materials and Secondary Slab Zinc (March 31, 1941); Bituminous Coal (April 2, 1941); Iron and Steep Scrap (April 3, 1941).

courage the use of substitutes for lumber so that the industry has much to lose in too high a price, since markets lost to substitutes take years to regain.

Tin, rubber, and *manganese.* In order to insure adequate supplies at reasonable prices, stockpiles of these, and of other materials as well, are being accumulated—in some cases at prices below the world market.

In other cases, research in the development of substitutes is in process. There has been little need for the use of substitutes to date, but this research is being carried on so that in the event of necessity shifts to substitutes can be made. And in still other cases, as the need arises, demand may be restricted by the use of priorities.

Price, it is clear from these illustrations, is considered more as a resultant than as a prime mover in the productive process. Emphasis is upon supply and demand in the sense of expanding production, capacity, and imports, of curtailing exports and arbitrary withholding or cornering of markets, and, in the last resort, of limiting demand in what are for the duration of the emergency the less important sectors of the economy.

Success under this type of approach necessitates constant watch of markets. Price data provide only part of the needed information; inventories, capacities, production and so on must also be kept under surveillance. But because of the more immediate availability of price data they are most likely to provide the initial clues to underlying market conditions.

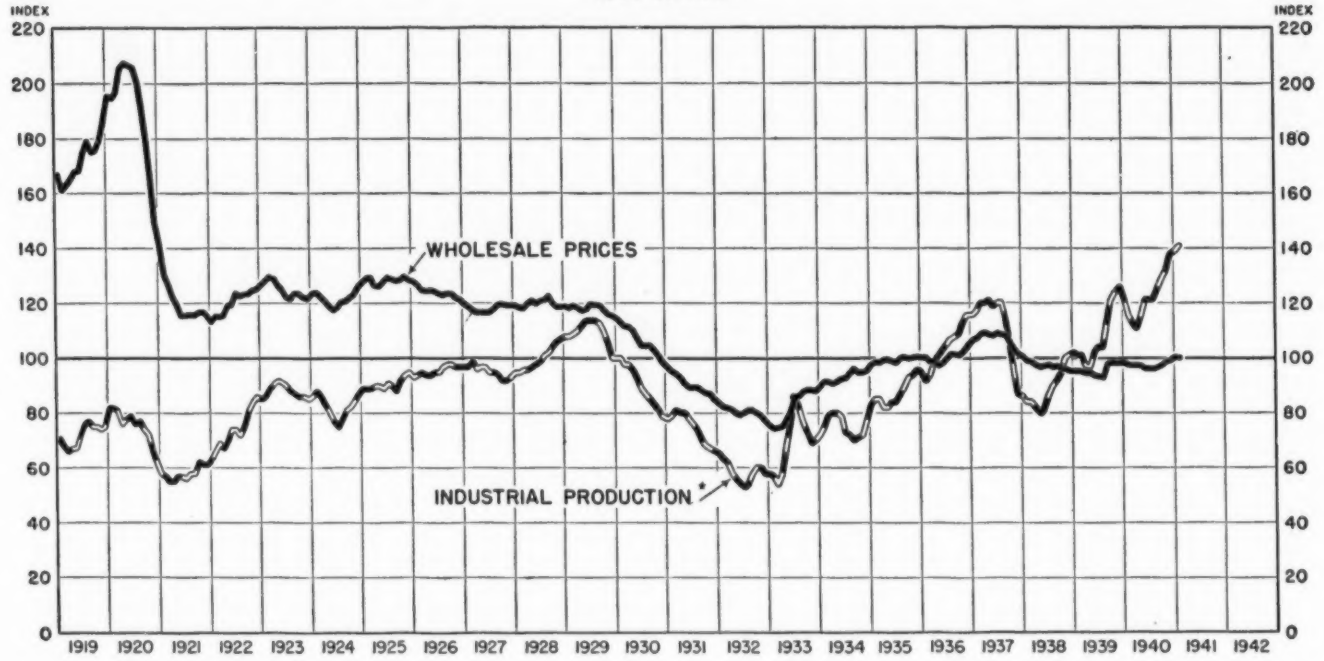
From what has been said it may appear that price indexes are not very important in the practical operations of the defense program relating to prices. Yet this is far from the fact. It just happens that, leaving aside the overall monetary and fiscal controls, action in the price field must be specific with respect to a particular commodity. Hence, in the most dramatic parts of the defense program, price indexes do not appear as explicit variables in the framing of problems.

But specific actions are not taken *in vacuo.* We know, for example, that price movements started in one sector have a tendency to spread either because of their effects on costs and competitive products, or because of the rôle of price indexes in escalator clauses in wage and other contracts, or because of their tendency to act as sympathetic vibrators. Price indexes provide clues as to whether, because provision has been made for flexibility, that provision for flexibility has been abused.

While the precise relation in which price indexes stand to many of the practical problems faced in the defense program is tenuous and difficult of exposition, yet nevertheless price indexes are indispensable equip-

INDUSTRIAL PRODUCTION AND WHOLESALE PRICES

1935-39=100



UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

* FEDERAL RESERVE INDEX OF INDUSTRIAL PRODUCTION ADJUSTED FOR SEASONAL VARIATION

ment to the proper conduct of such a program, particularly when it encompasses civil needs as well as the production of armaments.

That general purpose indexes are used as working tools and do have an important bearing on decisions is indicated by the chart of wholesale prices and industrial production which has been one of Commissioner Henderson's constant desk companions for some time. The striking feature of the chart is the stability of the price level for the recent period while production was rising sharply to new high levels. Of course, we in the Defense Commission like to think that our activities were in some way responsible for the stability of the price level while production was expanding sharply.

Further indications of the importance of price indexes are to be found in the recent work both in the development of special purpose indexes and in the extension of general indexes done by the Bureau of Labor Statistics at the request of the Defense Commission.

For the purpose of keeping a closer check upon retail markets than was previously possible, retail price and cost of living indexes of the Bureau of Labor Statistics have been placed upon a monthly rather than a quarterly basis. In addition, for the purpose of following local repercussions of defense contracts, arrangements have been made for the collection of price data in smaller towns not previously covered, particularly those directly affected by defense orders.

Prior to the establishment of the Defense Commission, but in response to the situation created by the outbreak of war in Europe, a daily index of the spot prices of 28 basic commodities was constructed by the Bureau of Labor Statistics. This index enables a close watch to be kept of the course of those prices which tend to set the pace and act as levers in the whole price structure.

Directly related to the procurement and planning aspects of the defense program are the indexes of 14 strategic materials and of 15 critical materials—the former being materials for which we depend in whole or in substantial part upon sources outside the continental United States, and the latter being materials not quite so essential or which are obtainable in more adequate quantities from domestic sources.

Now in process of preparation are indexes of the price of waste materials, of import commodities, of export commodities, and of machine tools. The waste material index is important because such materials are alternatives for virgin materials and tend to be sensitive barometers of changing market forces. The export and import commodities indexes are for the purpose of measuring the effect of world conditions upon our price structure, while the machine tool index is for the purpose of meas-

uring price changes in an area subject to extreme pressure upon capacities under the defense program.

Also, in process of preparation are indexes of prices of individual building materials on a delivered basis by geographic regions to meet the need of measuring the impact of defense construction in local areas and to aid in the planning of construction activities.

With all these newer indexes added to those previously available, we feel that, for the time being we have a pretty good set of indexes and of price material generally for following price trends and price levels. How well prepared we are may best be seen by taking a look back some 25 years to the last time national defense became an acute problem.

In 1915, the Bureau of Labor Statistics had just started to publish a wholesale price index on a monthly basis; about 250 commodities were covered and weights were rough. Contrast this with the current work of that Bureau. Today data for about 5,000 commodities are compiled and for a majority of these, compilation is on a weekly basis. Nearly 900 of the series are used in the computation of an all-commodities index of wholesale prices; and that index as well as indexes for 10 major commodity groups are published weekly.

In the field of retail prices and the cost of living the contrast is even sharper. In 1914, the Bureau of Labor Statistics collected prices for 23 foods in 41 cities each month and price data for coal in most of those cities. Today, we have indexes of the cost of living and of retail prices for some groups of items prepared by the Bureau of Labor Statistics, not to mention those prepared by private agencies.

In fact today, the Bureau of Labor Statistics alone has more price material readily available for use than all the price index factories in existence in 1914. This time we don't have to start almost from scratch as we had to do in the 1917–18 period. And no matter how much of a strain is placed upon the economy during the next few years, one may feel confident that it will not be necessary to adopt priorities for the consumers of the price index industry.

Such further work on price indexes as may be initiated under the defense program will most likely be along the lines of special purpose indexes. Examples of the path this development may take are: indexes designed to be of use in procurement activities for selecting commodity specifications or for the carrying on of contract negotiations; and indexes designed to measure the terms of trade between our country and the Latin American countries.

The problem of measuring price balance is one on which further work needs to be done. Balance in the price structure may be gleaned from

extensive comparisons between various indexes such as those frequently drawn between raw material and finished goods prices, between farm and industrial prices, between capital goods and consumers goods prices, and so on. The index of wholesale price dispersion constructed by Walter Keim of the Bureau of Labor Statistics is one of the most useful contributions so far made in this direction. His original work was done while on the staff of the Work Projects Administration and has been published by that agency. There ought to be more such contributions as Mr. Keim has made.

The availability of price and other data during recent months has been a tremendous asset on the side of orderly and vigorous development of economic activities. Those who during the years have labored long on the theory of price indexes, on the extension and improvement of the basic observations, and on the computing may justly take pride in the state of preparedness of their price index industry. To them must go part of the credit for the smoothness with which the defense program has gotten under way. And it is with the help of the data they have developed that we hope to avoid the evils of the World War period.

What was bad during the World War period was not so much the wild price movements *per se* but rather something deeper. Among the tenets upon which our economic organization is based is that income is a reward for services rendered and that the amount of income should be in some way coordinate with the services rendered. It was in the violation of these tenets that the evils of the World War period lay.

The most visible technique used for the violation of those tenets was, of course, the rapid spiraling of prices. But we know now that behind the price scenes there were many other elements at work from disorganization in the procurement activities to market manipulation, which not only made possible the price disturbances but also hampered the effort of the World War period. And it is by treating the factors behind prices that we hope not only to avoid the evils of the World War period but also to build a better and stronger economy for all.

AN APPRAISAL OF INDEX NUMBERS OF PRICES FARMERS PAY*

By Joel Dean and Mary Hilton Wise
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The United States Department of Agriculture Index of Prices Farmers Pay serves as an administrative aid to the Purchasing Power Parity program by indicating the changing value of the farmer's dollar in buying non-farm products. This special use of the index may involve restrictions on the type of index which may be constructed, its formula, the base period, commodities excluded, etc. In this paper, however, the Index of Prices Farmers Pay will be appraised by economic and statistical rather than administrative criteria.

The U.S.D.A. index contains two main series, prices farmers pay for commodities used in production, and prices farmers pay for commodities used in family maintenance. These series will for convenience be referred to as the cost of production and the cost of living indexes, respectively, although the index for consumption goods does not include articles produced on the farm and excludes most services, while the index for production goods also omits some items which contribute to farming costs.

The formula used for computing the index is the fixed weight aggregative type, with a pre-war base period, 1910–14. The weights for the cost of production index are those for the period 1924–29, while the cost of living index weights relate to the year 1936. In combining the two into a single series, the relative weights were determined by adjusting the value of commodities for farm family living in 1936 for the fall in the price level between 1924–29 and 1936.

The use of a fixed weight formula raises difficulties in the interpretation of the index. Recent developments in index number theory indicate that formulae involving both base and given year weights for cost of living indexes are superior to fixed weight indexes. In terms of basic utility theory it has been possible to define the true cost of living index as the ratio of the monetary expenditures of an individual which secure for him the same total utility or standard of living in two situations which differ only with respect to prices.[1] Similarly, a cost of production

* Revision of a paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940. We are obliged to Dr. O. C. Stine of the Bureau of Agricultural Economics and to Dr. Roger Hale of the Agricultural Marketing Service for critical review of this manuscript. We have profited from their criticisms, although we have been unable to accept all their suggestions.

[1] The controversy that has centered around the choice of an index number formula seems to have arisen largely because of imprecise definition of what was to be measured. Changes in "purchasing-

index is the ratio of expenditures in two different price regimes which enable the producer to maintain the same output if the production function, and all other things remain constant. On the basis of certain reasonable assumptions it has been shown by Wald that a close approximation to the true index of changes in the cost of living can be obtained by the use of Fisher's "ideal" formula.[2]

Unfortunately, the application of the "ideal" formula requires budgetary sampling for each price situation represented in the index series, in order to determine given year weights. The difficulty of such an undertaking is perhaps sufficiently indicated by the time required for the Consumer Purchases Study, begun in 1936 and only recently completed. Index numbers requiring comprehensive quantity sampling for each period under consideration are perhaps infeasible at the present time, unless continuous small samples could be taken.

Several compromises might be attempted, however. If weights cannot be determined every year, they might be determined every five years; in computing an index number, base year weights could then be combined with weights determined for the period nearest the year in question. This seems to represent a superior solution to a periodic shifting of the weights, which is the practice of the Bureau of Labor Statistics, although periodic shifting is to be preferred to a fixed weight series.

If it becomes administratively feasible to shift the price base to a recent period, comparisons of present prices with very early prices will not be made any more inaccurate, while comparisons between recent years will be improved.[3]

In attempting to choose a formula which will give the index a clear meaning, it must be emphasized that the following simplifying conditions are assumed in developing suitable formulae for an unequivocal

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power," "the value of money," or "pure price change" do not convey an exact meaning until they have been related to basic utility theory. The reader is referred to the following articles in the *Review of Economic Studies:* H. Staehle, "A General Method for the Comparison of Price of Living," Vol. IV, June 1937; A. P. Lerner, "A Note on the Theory of Price Index Numbers;" and R. G. D. Allen, "Some Observations on the Theory and Practice of Price Index Numbers," both in Vol. III, October 1935. The following important articles appeared in *Econometrica*, Vol. VII, January 1939; H. Schultz, "A Misunderstanding in Index Number Theory: The True Konûs Condition;" and A. A. Konûs, "The Problem of the True Index of Cost of Living."

[2] A. Wald, "A New Formula for the Index of Cost of Living," *Econometrica*, Vol. VII, October 1939. See also R. Frisch in the same journal, Vol. IV, January 1936. For similar work on production index numbers see an unpublished paper by H. G. Lewis and L. Court, "Production Cost Indices."

[3] The Central Statistical Board has recommended the average of the period, 1935–39, as a suitable base period for all government indexes. Dr. Hale has pointed out to us that the period 1935–39 cannot be considered a "normal" one if we take the average relation which has existed over a past period between prices received and prices paid by farmers as a criterion of normality. Prices received by farmers have averaged 88 per cent of prices paid for commodities over the past 30 years, as compared with only 82 per cent in the period 1935–39, according to a comparison of these indexes on a 1910–14 base. It is doubtful, however, whether an average of relative prices over past periods can be interpreted as a normative equilibrium position to which the economic system should or will return.

comparison of the cost of living or the cost of production in two different periods: (1) that the basic pattern of consumers' tastes (or producers' technology and anticipations) remains unchanged; (2) that the same selection of commodities is available in the two situations; (3) that the group of consumers or producers for whom the index is being prepared is homogeneous with regard to tastes and circumstances. In other words, a good approximation to the true cost of living index is only assured by any formula when substitution among goods results only from changes in prices.[4]

Obviously, any assumptions about the constancy of consumers' tastes or of technical methods are unjustified in considering index number comparisons over the last 30 years. The introduction of automotive equipment alone has revolutionized farming methods, and many new commodities have made their appearance in the consumer's budget. But doubt about the accuracy of index numbers using both base and given year weights only reinforces the suspicion that no valid economic interpretation can be attached to an index employing the same weights over a period of 30 years.[5]

The question of changing weights cannot, of course, be separated from that of changing tastes, quality, technology and product availability. Farming methods have undoubtedly undergone great changes since 1910. Old line types of farm equipment have been notably improved in efficiency and durability, while the introduction of both mobile and stationary power units has modified both the methods and scale of farming. An example of greatly improved equipment is to be noted in the case of rubber tires. The tire cost per mile of automobile travel today, as estimated by the Department of Agriculture, is only 25 per cent of what it was 25 years ago, as a result of an increase of 700 per cent in estimated miles of service per tire.

Although engineering estimates of increases in efficiency do not measure economic gain, there are many classes of commodities in which an increase in durability or performance will have a similar significance to a fall in price. An increase in the mileage life of rubber tires of 5 per cent is as acceptable to most people as a fall in price of 5 per cent. Prices per car mile of tires might, therefore, be a less misleading component in an index than unadjusted tire prices.

The substitution of prices of technically defined equivalents (i.e. tractor acres instead of tractors) for prices of conventionally defined com-

[4] Although these ideal conditions are never completely fulfilled we should seek to approximate them and should recognize that departures from these conditions result in errors additional to formula biases.

[5] If it is necessary, for statutory reasons, to compare 1940 with 1910–14 (although such a comparison can at best mean little) weights as nearly typical of 1940 as possible should be crossed, probably by the "ideal" formula, with the best weights that can be determined for the base period.

modities would require care.[6] However, for certain types of producers' goods, whose services are highly specialized, statement of prices in terms of technically defined service units would undoubtedly increase the economic significance of the series.[7] Although the use of technical criteria in the definition of commodities always involves some measure of economic irrelevance, in many instances the consequent distortion of the index will be much less than that resulting from the use of ordinary commercial units. Since the definitions of commodities which alter rapidly in economic characteristics are merely conventional, recognition should be given to the fact that indexes that include such commodities are not comparable over any considerable period of time. Frequent revisions of the weights, while not making dissimilar periods comparable, will serve to make the indexes more representative for each period and will make the direction of change of the index at any point in time more significant.

INTRODUCTION OF COMMODITIES

In a fixed weight index, the changing importance of various commodities is only indicated in an indirect and possibly perverse fashion by whatever changes in prices result from shifts in demand. This weakness, which lies concealed for the most part, is brought into the open when a shift in demand is so great that a commodity must be added or dropped from the index. The question as to when, and at what level to introduce a new commodity into a fixed weight index must be answered in a somewhat arbitrary fashion, although the point at which commodities are introduced will have an important effect on the level and even the trend of the index.

When adding a new commodity to a group, the practice of the U.S.D.A. is to make the index of the new commodity equal to that of the group of commodities to which it is added, regardless of the price history of the new commodity. The criteria for introducing a new commodity seem to be two: (1) its price must have become fairly "stable" at the time of its introduction, and (2) the commodity must represent a significant portion of the farmers' expenditure. Since rapid changes in

[6] It is assumed that hedonistic equivalents for consumers' goods cannot at present be calculated accurately. However, see Andrew Court's article "Hedonistic Price Indexes," in the *Dynamics of Automobile Demand*, General Motors Corporation, N. Y., 1939.

[7] There are many difficulties in formulating economic equivalents objectively, among which may be mentioned:

(1) Technical equivalence on the basis of comparative average cost per unit will be altered by changes in relative prices of inputs.

(2) Producers are differently affected by the various aspects of technical advance (e.g. speed, durability, capacity, etc.).

(3) Estimates of average cost may prove erroneous if the equipment is outmoded before it wears out.

Notwithstanding these difficulties, the use of technically defined commodities would in many cases clarify the economic significance of the index.

prices of goods purchased by farmers are likely to be downward as the result of improvements in the technique of manufacturing new articles, the exclusion of fluctuating prices probably gives the index an upward bias. Such a bias may result in understatement of the relative well-being of the farmer, since a new article in attaining an important place in the consumer's budget displaces products of less utility per dollar of expenditure.[8]

No entirely satisfactory solution to the problems involved in introducing new commodities is possible. While no commodity should be omitted which represents a sizable proportion of consumer expenditure, consideration should be taken both of the price history of the new commodity and the commodities it displaces in determining the level at which it should enter the index. Refusal to introduce commodities until their prices have become stable may result in serious misrepresentation of the effects of the revolution in techniques which have cheapened consumers' goods and made farming methods more productive.[9]

The effect of the introduction of new commodities at a more or less arbitrary level is strikingly illustrated in the case of motor vehicles. Expenditures for tractors, automobiles, and motor trucks, as nearly as can be determined from available data collected by the U.S.D.A. amounted to about 69 million dollars, or about 1.2 per cent of total farm income in 1910. From 1910 to 1914 such purchases averaged about 25 per cent of farmers' purchases of all types of machinery. Yet motor vehicles and automotive machinery were not introduced into the index until 1917, when expenditures for these articles amounted to 55 per cent of all farm machinery and about 4 per cent of farm income.[10]

The U.S.D.A. indexes for tractors, for automobiles, and for automotive supplies were compared with indexes for the same groups computed on an actual 1910–14 base, using the same weights as the U.S.D.A. index employs and price data supplied by the U.S.D.A. it-

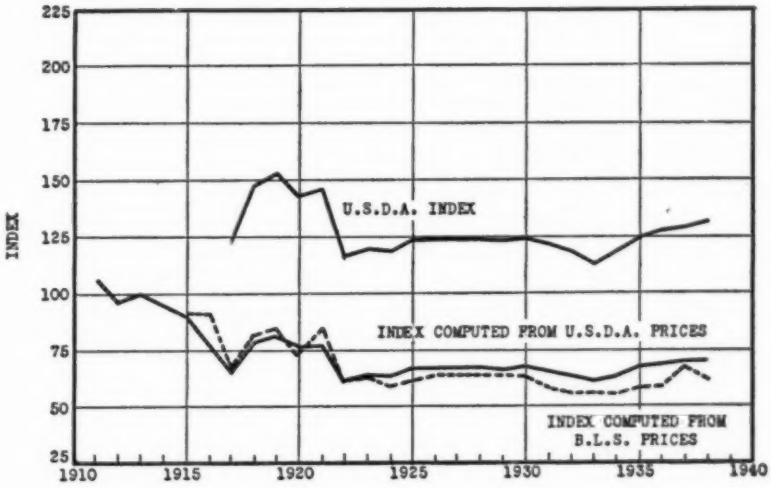
[8] For example, rayon, preferred to cotton for many uses, and constituting a cheap substitute for silk, has raised consumption standards of most income groups. Yet rayon fabric was introduced into the U.S.D.A. index in 1930 at a level of 146 (since this was the index of its group—clothing, in that year). The introduction of rayon into the index in this manner, therefore, fails to reflect any gain to the consumer.

[9] For example, electric rates are not yet incorporated into the index although the U.S.D.A. states that by the end of 1936, 15 per cent of farms in the United States were receiving electric current. In some regions the proportion was over 60 per cent. In the case of electric power for farm production, the U.S.D.A. considers that the electric power rate may not be sufficiently stabilized to warrant introducing power rates into its index. See *Income Parity for Agriculture*, Part III, Section 2, "Rates for Electricity for Farm Home and Farm Power."

[10] See Table I, Part II, Section 3 of *Income Parity for Agriculture*. When introduced, that portion of automobile purchases allocated to productive activities was assigned an index of 122—the 1917 level of old-line farm machinery. Similarly, that portion of automobile purchases allocated to farm living was introduced at 120, because the price of a group of commodities designated as household supplies was at that time 120 per cent of pre-war. This group consisted of brooms, soft coal, hard coal, kerosene, laundry and toilet soap, laundry starch and wood.

self in the recent preliminary reports of the series *Income Parity for Agriculture.* The chart shows the results for tractors. The series for automobiles and automotive supplies exhibits highly similar behavior.

COMPARISON OF INDEXES OF PRICES PAID BY FARMERS FOR TRACTORS
U. S. Department of Agriculture Indexes, 1910–14 =100
Bureau of Labor Statistics Wholesale Price Index, 1913 =100



The disparity between the U.S.D.A. series and the ratios of actual prices does not necessarily lead to the conclusion that automobiles, supplies, and automotive equipment should have been introduced at the actual ratio of their prices to their 1910–14 prices. Neither does it show that the Department should have introduced the series in 1910, since with their present weights the group would probably have exaggerated the farmers' benefit from declining tractor prices. Nevertheless, the graph does indicate the degree of arbitrariness involved in the use of fixed weights which cannot be representative of widely divergent periods.

NON-HOMOGENEITY OF GROUPS SAMPLED

The United States is characterized not only by wide regional disparities in the level of income, but also by wide regional variability in the consumption patterns of similar income groups, particularly in rural sections. Since price changes will affect various groups differently, index series should be computed for each major classification of population according to living standard. Regional indexes should be given wide circulation in order to avoid misleading indications of changes in relative well-being for various sections.

The same considerations seem to apply with even greater force to farm production indexes, both because of regional differences in major crops, and because modern and antiquated methods of farming persist side by side.[11]

Because of the diversity of consumption patterns and farming techniques, separate indexes by regions and farm-types are urgently needed. Fortunately, it is easier to obtain homogeneous geographical samples than to secure successive samples that are comparable over a period of years.[12]

COMPARISON OF OLD AND NEW SERIES

The index numbers of Prices Farmers Pay were considerably revised in 1939. Both the old and the new series include the same subseries with the exception of the addition of livestock to the production index. Nevertheless, a number of new commodity components of the subseries have been added and there has been some regrouping. Although the direction of movement of the old and revised indexes is highly correlated, the discrepancy between the two series amounts to as much as eight or ten points over much of the range since 1923 and the new index lies below the old from 1921 onward.

The disparity between the new and revised series cannot be considered negligible. It results from (1) corrections of price series, (2) improvement of weights, (3) possible shifts in expenditure patterns between 1929 and 1936 (in the case of the cost of living index).

Even though the weights for the production index are for the same period in both the old and new series, however, it has been found necessary to modify them substantially.[13] If the sampling for cost of living indexes was qualitatively comparable with cost of production sampling in the old series, modification of weights in the cost of living index are more likely to represent corrections for previous sampling deficiencies than to indicate change of habits of expenditure.[14]

The Consumer Purchases Study, from which the present weights for the family maintenance index were taken, appears to have been as

[11] In the 1930 Census, over 90 per cent of farms were reported owning automobiles in Iowa and Nebraska, as compared with less than 50 per cent in the South as a whole and only 25 to 30 per cent in some southern states. Such figures indicate that the non-homogeneity of the universe sampled for the index at any point in time may exceed the non-homogeneity of successive samplings through time, although the latter source of trouble has been much more emphasized.

[12] A few state index numbers are being constructed, but usually with the same formula and weights as the U.S.D.A. national index.

[13] Some reduction in the weights of all former groups was necessary to allow for the inclusion of the new series, livestock, which was given a weight of 12 on the basis of 100; it thus appears more important than any of the 9 component series with the exception of feed. The omission of livestock from the original series, is, therefore, very difficult to understand. Building materials were assigned a weight of 10 in the new series, as compared with 16 in the old. Changes in other groups of two or three points have been made.

[14] For instance, clothing was reduced from 30.4 to 22.0. Food was advanced about 2 points and building materials were reduced in importance, while automobiles advanced from 6.3 to about 10. A severe drop in the relative importance of food might accompany sharply rising incomes, but otherwise changes of such magnitude seem to indicate sampling deficiencies either in the past series or the present series, or both.

extensive as is feasible, and to have been carefully planned. We are led to hope, therefore, that the farm budget drawn from this study presents an accurate composite picture. If future changes in weights are based upon studies of comparable accuracy, they may be accepted as showing predominantly the change in consumer spending habits.

COVERAGE AND PRICE SAMPLING

The prices of services, which account for between one-sixth and one-fifth of the farmer's living budget, are not included in the cost of living index. This deficiency has been partly remedied by the compilation of special index numbers for services and also for commodities not included in the main series. These data are available for the periods 1910–14, 1924–29, 1932 and 1936, and may be combined with the general index for these scattered periods when desired. Of more importance, perhaps, is the lack of a series of prices for commodities raised and consumed on the farm.[15]

For the production budget, separate series have been developed for prices paid to hired farm labor, and for taxes and interest. These are frequently incorporated into the index of production when it is desired to compare the latter with the index of prices received by farmers.

The price data used in the index represent cash transactions at local independent stores. While independent stores supply farmers with a high percentage of some articles of consumption it seems undesirable to confine the price sample to these outlets.[16]

In 1939, about 20,000 independent merchants submitted price data to the U.S.D.A. on the items included in the index.[17] More quotations per item are collected on food prices than for any others, although over

[15] It is estimated by the U.S.D.A. that in 1941 farm produced commodities will be, on the average, over half as important in the family maintenance budget, as commodities purchased in the market. This fact appears significant when we consider the wide regional differences in the proportion of farm production consumed on the farm and the probability that farm families divert more resources into family maintenance when market prices are low.

[16] A survey by the U.S.D.A. in 1935 indicates that mail-order houses supply about a quarter of farm clothing, one-fifth of household supplies and furniture, and smaller proportions of other articles. Chain stores are credited by the survey with one-fourth of food purchases, one-sixth of clothing purchases, and smaller amounts of other articles. The U.S.D.A. emphasizes the need for including quotations from chain stores and mail-order houses, since both the level and trend of prices in these types of retail outlets may differ from those of the independent stores. Data are being assembled on prices charged by chain stores and mail-order houses, which presumably will be incorporated into the index numbers in the future.

[17] One of the knottier problems encountered in securing price quotations was that of prescribing specifications for the commodities included, since for many commodities there are no recognized standards. According to A. R. Sabin, of the Agricultural Marketing Service, broad specifications for commodities have proved to be the best approach to the problem. "Narrowing of specifications restricts the coverage of the field and reduces the representativeness of estimates based on such specifications." ("Prices Paid by Farmers, an Appraisal," the *Agricultural Situation*, September 1939, p. 9). For some commodities, therefore, the respondent is told simply to quote the price for the type that farmers most frequently buy. The resulting variability in commodities sampled is likely to be of little significance, however, unless there is a systematic tendency for lower quality articles to be purchased during depression years, or unless the modal quality bracket is tending upward.

5,000 towns report clothing prices and over 3,000 furniture and furnishings.[18]

Accurate price sampling is particularly difficult for certain types of commodities, as is illustrated by rather pronounced differences between price series as reported by the Agricultural Marketing Service (which are used for the Department of Agriculture indexes) and the Bureau of Labor Statistics. Even though the base periods are approximately the same, the dispersion between the automobile and automotive supplies series based on the published prices of the A.M.S. and those based on the B.L.S. wholesale price index seems to be greater, especially in recent years, than is explained by the fact that one is a series of retail, and the other a series of wholesale prices.[19]

In conclusion, certain suggestions may be summarized. In view of the desirability of using Fisher's "ideal" formula for computing the index, the possibility of obtaining new weights each year by means of permanent, small stratified samples merits consideration. On the basis of the extensive Consumer Purchases Study, it might be possible to select a small number of families typical of each major region, farming type, and income group and to have these families keep records of their expenditures. The more homogeneous the sub-groups the smaller may be the number of families sampled. Construction of subsidiary cost of living and cost of production indexes for various regions and types of farming seems desirable, even if the weights must be based on very small samples.

Failing this, revision of the weights every few years seems desirable. The base period should probably be shifted to a more recent period, possibly 1935–39, if this becomes permissible under the revised statutes. Introduction of new commodities as soon as they assume importance in the budget regardless of whether their prices are stable is recommended. Although no satisfactory theoretical solution exists for the problem of the price at which the new commodity should be introduced, it would seem logical to have regard both for its price behavior while it was growing in importance and for the price of the commodities it supplements. Expression of prices of certain commodities in terms of units of service (e.g. tire miles and truck ton miles) rather than in terms of conventional units appears to merit further consideration.

[18] Although the towns returning food price quotations are of all sizes, there are a large number between 5,000 and 50,000 and 82 towns over 50,000 in population. To the layman this would appear a rather high coverage of the larger centers of distribution; nevertheless, studies of farm buying habits may have shown that this rather intensive sampling of large towns is justified.

[19] Automobiles on the basis of A.M.S. series (1910–14 = 100), stands at 87. The B.L.S. wholesale price series for automobiles using the same weights (1913 = 100) is only 67.2. The A.M.S. price series gives an index for tires of 59.6 while the B.L.S. stands at 28 in the same year. For gasoline, the price series of the A.M.S. gives an index of 97.4 for use in automobiles and 68.8 for tractors, as compared to the B.L.S. index of 67.2 in 1938.

PRINCIPLES AND PROCEDURES FOR PUTTING ACROSS BUSINESS STATISTICS REPORTS TO EXECUTIVES*

By John W. Boatwright
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In its broadest interpretation our present problem is how to present the results of research effort to the executive. Let us first narrow the statement of the problem.

1. This paper is not concerned with ways and means of putting across commercially published statistical reports.

2. No consideration is given to problems incident to presenting weekly, monthly, quarterly, or on any other time basis an intricate system of chart control for the chief executives of a corporation to follow and by which to direct the activities of their organization.

3. No consideration will be given to the problems incident to presenting all manner of business statistics to all manner of business executives.

There may be other sub-classifications of this broad topic which should be eliminated, as this discussion is limited to the principles and practices of presenting specific problem analyses to the executives of a particular corporation, no matter what its corporate title may be.

Statistics and statistical methodology are limited to data available and to various manipulations that the trained research man will adopt in attempting to reach sound generalizations based upon a multiple number of observations so that a solution of some definite confusion or uncertainty may be presented to management. Statistical analyses are not ends in themselves but are a means whereby the trained analyst seeks to find a clear-cut path through the fog of uncertainty.

The Receivers. Business executives make decisions about the best course of action at particular times when confronted with particular problems. They are eager for help in finding the solution of many of the problems which must be encountered daily. Their objective is to eliminate the pure chance element and reduce uncertainty to a minimum.

The very existence of a commercial research department on a corporation payroll is vivid testimony that the executives of that corporation desire whatever assistance research men may be able to give to management in selecting proper courses of action at the right time. There is an obvious desire for the results of statistical and economic analysis. The audience, therefore, is receptive regarding the results of analyses of problems.

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 28, 1940.

The Transmitters. The other side of this human equation is represented by the members of the commercial research department. What is essential from their point of view in this process of thought transmission?

The objective of the research man is to marshal factual evidence pertaining to the various problems of management, formulate major conclusions thereon, and recommend that course of action which appears best in the interests of the public, employees, and stockholders. He is obligated to acquaint himself sufficiently with the various parts of the industry in which he is working to be able to draw true inferences from the data with which he is working. He must be strictly honest in his presentation of factual evidence and possessed of a thorough understanding of sound sales procedure. He must be impervious to flattery and possessed of the courage of his own convictions. It is sometimes necessary that he stand absolutely alone on specific policies. He should maintain close contact with the sales department, know its promotional activities, and its operating policies.

Many problems assigned by management to a research department are of an urgent nature by the time they are called to the attention of the research analyst. Speed is the essence of many actions which must be taken in the business world. It is essential, therefore, that the good research man be able to select the more promising approaches to the solution of the problem and follow these particular avenues of approach first before resorting to less promising alternate approaches to the solution of the problem. This frequently requires a careful balancing in the mind of the analyst of the importance of time and the ultimate in accuracy. The leisure and thoroughness of academic research are seldom available to the commercial analyst as it is frequently necessary that the output of a department be the result of long hours of grinding, often under considerable pressure to meet deadline dates.

The successful research man must likewise be a good salesman. The analyst should be able to organize his thinking in logical sequence so that the presentation of evidence will lead to an easy and ready acceptance of his conclusions by the executive audience. Likewise, it is a material asset if the research man is capable of speaking directly and forcefully in support of his analyses and findings.

Where these essential requirements are deficient in any of the members of a department, extremely careful supervision and checking of results are necessary. To find individuals possessed of these characteristics is a major problem confronting any director of research activities to a far greater extent than is the problem of getting the results of his analysis before the executive audience.

The Exchange of Information. The essential characteristics of the two parties to the exchange of information have been briefly outlined and the problem limited to the exchange of a particular type of information between these two groups. What is the best way of exchanging this information? This varies widely according to the functional set-up of different organizations.

In an organization where research is (1) directly responsible to the chief executive, (2) free from departmental influences, (3) given absolute freedom of the press so that any finding or recommendation may be presented to the chief executive of the corporation, and (4) given opportunity for frank discussion and interchange of ideas by the research department and management, it is my belief that the written report form offers one of the best solutions.

Under these ideal conditions the first step in the procedure is usually a frank discussion between management and the research representative as to the exact nature of the problem to be analyzed. Do not anticipate securing in this manner a complete and detailed outline of the problem to be solved, as frequently the assignment will represent some confusion on the part of management, but certainly our efforts can be directed more intelligently if we know what these difficulties really are. At times the assignment may be extremely broad and very general because the exact nature of the problem may not be apparent to either management or the research man until a sufficient amount of exploratory work has been done to evaluate more thoroughly the true dimensions of the study to be conducted.

Having secured as clear an outline of the problem as it is possible to get from a discussion with management, exploratory work is undertaken. As results of this materialize, careful notation should be taken and notations converted into a complete written analysis to the management. Such a report becomes at one time a reflection of the problem to be analyzed, a reflection of the audience that is to receive the results of the analysis, and still a reflection of the analyst conducting the study.

Certainly a report having to do with an analysis of various expense items would differ markedly from a public attitude study or from the type of analysis incident to the introduction of a new product. Mechanically they may be similar but actually there would be a wide difference in the presentation thereof so that clarity of thought transmission would be possible.

A report likewise is a reflection of the audience to which it is directed. Do not underestimate the significance of this particular feature in drafting your presentations. The writer should be thoroughly conversant with the members of his audience, know their interests, their prob-

lems, and their particular way of acquiring, absorbing, and applying information relative to the various analyses conducted.

The report is naturally a reflection of its author as it is a concise picture of his manner of thinking, working, and arriving at conclusions in the conduct of a business. Under these conditions the report in its written form will achieve the following results.

State the Problem Clearly. Frequently this is one of the most difficult parts of report writing—knowing exactly the limitations of the subject matter meriting particular attention on the part of management and justifying consideration for inclusion as part of the analysis. Often a careful weighing of comparative significance of different phases of the problem is necessary so that the report in its written form may possess the desired conciseness, simplicity, and directness which are essential to good reception.

Outline Briefly the Approach to the Solution of the Problem. This is of primary importance when the analysis under consideration is of a non-recurring nature. Many departments have a certain number of reports which recur annually and in which the writer can advantageously brief or omit any detailed description of the procedure to be followed in the analysis of the problem.

Present the Evidence. All significant evidence bearing on the problem under consideration should be presented step by step in the logical sequence of the evolution of the solution of the problem. There is no mechanical means of outlining a procedure for best presentation of evidence on all problems to all groups of business executives. The form of presentation must be an adaptation which is based on the interests of the audience. For some particular audiences charts may be a handicap rather than an assistance. Probably it would be safe to say that for most business executives charts should be used only when a well organized table of carefully arranged data would not present the idea equally well. When charts are used, keep them simple. Too many thoughts consolidated on one chart requiring long and tedious study will seldom receive the attention that the author would desire. Frequently use of logarithmic paper does not result in the true interpretation of the points it is desirable to bring out. Pie charts are seldom easy of correct interpretation of relative values, for the eye is slow to draw correct conclusions for evaluating comparative significance of tractors, horses, or other objects drawn to different scales to represent comparative values.

As evidence is presented on any one segment of the problem, draw conclusions and recommendations thereon directly associated with the factual evidence. Upon completion of the report, all important conclusions and recommendations should be recapitulated in the first few

pages of the analysis. Avoid criticism of individual departments or individual members of a department, making recommendations based purely on factual evidence impersonally presented.

Draw True Inferences and Deductions from Evidence Presented. It is at this stage of the report that the research analyst must exercise the greatest care in his thinking processes to insure that his thinking is entirely practical in view of all ramifications of the problem at hand. It must be completely fearless in presentation of true inferences from facts previously presented. It is important that the significance of the various deductions be interpreted and applied to the business of the particular corporation and, in addition, that the full significance in terms of profit, sales policies and procedures, and competitive advantages resulting therefrom be pointed out.

Frequently such deductions may lead to a changed course of action as compared with policies which have been in existence for a considerable period of time. Under these conditions it is well to anticipate objections which may arise from the new proposed course of action and meet them directly in the presentation. Pre-selling of such ideas by personal contact with any persons influenced by the change is often beneficial in securing cooperation in the desired course of action. This pre-selling may take the form of mentioning to executives concerned some of the principal findings prior to submitting the actual report.

The research ideal should not be surrendered in such discussions but frequently the research man's understanding of the complete problem will be beneficially influenced by such procedure, and even if no such benefit is derived therefrom, it is the sporting thing for the research man to do, so that the executive affected may have a fair time and opportunity for presenting his case in justification of any policy previously formulated. Where clashes of opinion are inevitable, the research evidence must be presented in a positive manner if it is to overcome the natural inertia to change of long accepted procedure.

Recommend Courses of Action To Be Taken by Management in Its Choice Determination Function. All recommendations included in the report incident to the presentation of evidence and inferences drawn therefrom should be recapitulated in the front of the report. This provides the management with a ready summary of the principal results of the analysis for subsequent open discussion before a steering committee. The report in its completed form should be brief, direct to the point, concise, neatly prepared, and easy to read. Its set-up from beginning to end should provide the best sales approach to the important task of influencing the selection of the proper course of action to be adopted. It should then be submitted to all members of an appointed steering

committee, of which the chief executive or the executive vice-president serves as chairman.

The members of the committee should have the opportunity to read, study, analyze the contents of the report and submit rebuttals to all members of the committee where desired. After each member has had an opportunity to analyze the contents of the report, a meeting should be called for a frank discussion of the problem and recommended courses of action proposed by the research department. Each recommendation should be treated separately and completely, and either accepted as a modification of existing policy or rejected. In any such discussion it is essential that recommendations be discussed impersonally, impartially, and with an even temper by all parties concerned. The research man should be able to discuss the various phases of the study and the application of courses of action recommended.

The receptivity of the research reports is frequently enhanced with the passing of time, enabling the business executives to increase their contact with the findings of the department. If the department builds up a reputation of practicality, resourcefulness, and impartial judgment, it is a reasonable expectancy that impartial hearing and eagerness for any recommendations and conclusions may be anticipated.

Throughout this brief discussion I have probably placed greater emphasis upon the sales aspect of the research man's duty than is commonly encountered. What is more important, if commercial research is to contribute its maximum to sound management, than that the individual who has collected, assimilated, analyzed, pored over the data relative to any given problem, should first state clearly what appears to that individual as the best course of action to pursue, depending primarily upon his evidence to substantiate his opinion, and then sell the results of that work to the best of his ability?

There must be a cooperative spirit between commercial research men and management if a research department is to justify its existence. The interests of the executives and the analysts are identical as they both seek the best course of action to take when confronted with particularly confusing conditions.

Where, then, is the real problem of presenting statistical findings to business executives? The real problem is to find men meeting the qualifications of the research man above enumerated, who will take from the desk of management a wide range of business problems and by using the particular tools at their disposal, determine what course of action offers greatest promise, then sell the results of their analysis and thus influence choices made by business executives.

HOW THE LIBRARIAN WOULD LIKE TO FIND STATISTICS*

By Rose L. Vormelker, *Business Research Librarian*
Cleveland Public Library, Cleveland, Ohio

THE LIBRARIAN represents the middleman in the distribution system for statistics. The librarian ordinarily compiles no statistics except those specifically related to some phase of library work, nor is the librarian the ultimate consumer of statistics. The librarian is concerned chiefly with knowing what statistics are available and where, in order to produce them for clients of the library as requested. It is also desirable that the librarian know what statistics are not available and why in order that time not be wasted to produce something which does not exist or is not available for one reason or another, for instance, confidential figures.

There are so many misconceptions concerning the type of individual who uses the public library for information that it seems best to begin this paper with *who* requests such data.

In our Business Information Bureau (and this is probably true of any well equipped business library) requests involving statistical data are second only to the directory type of question, such as "Who are the officers of this or that corporation?" and "Where can I find out who manufacturers this or that commodity?"

These questions come from the manufacturer who wants to compare his output with that of the industry as a whole, from the industrial relations consultant who is working out a wage policy, from the labor leader trying to show trends of employment or unemployment, from the advertising agency planning a campaign, from the market analyst looking for new markets or re-arrangement of market areas, from the investor hoping to make the right decision concerning his dollars, from attorneys needing statistics for legal evidence, from trade papers to learn the extent of their market, from newspaper men and public speakers to give recognized authority to their conclusions, from trade association executives for information later transmitted to their members, from Chambers of Commerce planning industrial area analyses, from economists who use statistical data to guide them in watching trends in many fields, from researchers who are researching the researchers, from students, whose instructors have assigned very specific questions to them, and others.

* Revision of a paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

Occasionally but much more rarely than is generally supposed, an obviously "crank" question is presented such as, "How far is it to heaven?" or "How many marriageable Chinese girls are there in Englewood, New Jersey?"

Many of these people call on the library before beginning any work on their problem at all. Others think of it only as the last resort after all else has failed!

Some think the librarians are magicians when they produce quick answers to what has appeared as a laborious task to them; e.g. "How many insurance salesmen are there in Chicago, Cincinnati, Cleveland and Detroit?" Others classify librarians as morons when they fail to find what seems simple to them, usually adding with conviction, "The government must have such figures." In this class came the request from a corporation attorney for figures showing the amount of taxes paid by the United States Steel Corporation for support of the public schools in Pittsburgh. He was quite sure the *census* reports on *income tax* listed the names of all corporations in the United States in one column and all the taxes they paid in another, specifying the use to which this tax money was put.

The census reports—especially those for population, manufactures, agriculture, and distribution give us so many invaluable data that it seems we should really sing a paean of praise for them. An account of the many uses to which these reports are put would fill a book. Not only are the current volumes in great demand but even the old reports are frequently used. A short time ago one of Cleveland's leading executives was called upon to speak before a national business organization on the effect of technological development on the employment of office workers. For this question the very earliest reports were used to show how the number of office workers has increased by leaps and bounds despite the introduction of labor saving machinery. Excellent papers have been prepared showing the uses to which census data are put.[1] Many of the situations mentioned in these are duplicated daily in the important business libraries of the country. To be sure, hundreds of requests, not to be classed as "crank" requests, are made for statistical data which are not in the census field. A sampling of these from recent records of our Bureau follow:

[1] Cherington, Paul T., "The Uses of the Census of Business," this JOURNAL, Vol. 33, no. 209, Part I, March 1940, pp. 107–115.

Reed, Vergil D., "Putting Business Census Facts to Work for Chambers of Commerce," an address delivered at the Buffalo Convention of the National Association of Commercial Organization Secretaries, October 25, 1937.

Truesdell, Leon E., "Value of the Population Census for Research," *Annals of the American Academy of Political and Social Science*, Vol. 188, November 1936, pp. 329–339.

How many mortgage loans were made in 1940 in Cleveland and for what amounts?
What was the industrial production index number for chemicals for the last half of 1940?
What was the amount of car loadings, weekly from the beginning of our entry into World War I to the end of 1918 and how did these figures compare with car loadings during the depression of the thirties?
How do the sales of gas refrigerators compare with those of electric refrigerators in certain specified communities?
What was the cost of living index in Cleveland and Detroit for the last ten years?
How many parts are there in an airplane?
How many man hours are required to make a bomber?
How many radio phonograph combinations were made annually by each of the larger companies in the last five years?
How many men are required behind the scenes for every man at the front?
How many corporations started in business last year and how many corporations failed?
How much coal was used in producing power in the last two years?
How many boys are in classes giving industrial training for defense?
How many women in Cleveland are available for employment in defense industries?
How many jobs now held by men could be adequately filled by women, thus releasing men for military service?
What are salaries paid, costs, and profits in the clothing industry?
What was the value of United States agricultural products exported to Great Britain, China and Greece last year?
What profits, if any, were made by producers of soy beans?
What was the price of black pepper on December 13, 1940?
What were the wage rates in the steel industry in the World War and how do they compare with present rates?
What was the high and low price of Allegheny Corporation 5's of 1949 for February 1934?
What is the prevailing factory cost of sales in the automobile industry?
What is the amount of fire loss annually?
How much lubricating oil was produced in 1940?
What was the amount of our exports of power driven metal working machinery annually, 1919 to 1940?
What was the price of automobile sheet steel at Pittsburgh in May 1928, 1929, 1933, 1937?
What was the amount of sales tax collections for Cleveland and for Ohio in 1935?

To answer these, it is essential to have the figures compiled and released by government and quasi-government agencies as: United States Department of Agriculture, United States Department of Labor, United States Bureau of Foreign and Domestic Commerce, Securities and Exchange Commission, Federal Trade Commission, Federal Power

Commission, Interstate Commerce Commission, Temporary National Economic Committee, Board of Governors of the Federal Reserve System, and others; the reports and compilations made by state, county, and municipal offices and bureaus; data compiled and published by trade papers, trade associations, or private organizations.

Some requests which have presented problems, are those for data collected by but not published by the Census Bureau. Figures which will reveal the identity of establishments because of their location are withheld from publication as most statisticians and librarians know. However one large Cleveland firm expressed considerable annoyance when the figure giving the value of a certain chemical was included in the preliminary report but grouped with miscellaneous chemicals in the final report. The reaction of professors and students in collegiate business schools to this regulation has already been discussed in a paper in this JOURNAL.[2]

Still other problems arise because figures are needed in a form other than the one in which they are found. For instance, a firm which is expanding its plant facilities for national defense production was considering a number of locations in rural communities. This firm requested cost of living figures on a county basis with special divisions for rural and urban communities with the county.

Economists, market analysts, and other workers in the field of business and statistical research have frequent need for data for their own firm's market area or for some commercial area that is very different from the political subdivision for which figures are usually collected. This has also been commented upon in previous papers.[3]

The problems arising in trying to use occupational statistics and employment statistics have also been ably presented.[4]

The questions for which data are published present no problem other than that the librarian be informed of their existence. However, as the need for figures seems to have endless possibilities and the efforts to supply them are growing by leaps and bounds, some sort of master index to statistical sources, undertaken by people adequately trained in indexing procedures, would be a great time and temper saver.

[2] McLaughlin, Glenn E., "The Inadequacy of Census Data for Individual Industries," this JOURNAL, Vol. 27, no. 177, March 1932, pp. 37–44.

[3] Papers by James N. Holsen, Alonzo B. Cox, Ralph J. Watkins, Waldo E. Grimes, Paul T. Cherington, Casimir A. Sienkiewicz, F. L. Carmichael, on "The Industrial and Commercial Area vs. the Political Area as the Unit for the Collection of Business Statistics," this JOURNAL, Vol. 29, no. 185a, March 1934. Supplement, pp. 14–23.

[4] Palmer, Gladys L., "Some Considerations Involved in Appraising the Adequacy of Occupational Statistics," this JOURNAL, Vol. 36, no. 213, pp. 61–70.

Reede, Arthur H., "Adequacy of Employment Statistics," this JOURNAL, Vol. 36, no. 213, pp. 71–80.

A start—but only a start—in this direction has been made in the *Sources of Regional and Local Current Business Statistics*, by E. S. Moulton, issued as Domestic Commerce Series No. 115 by the United States Bureau of Foreign and Domestic Commerce; *The Economist's Handbook, a Manual of Statistical Sources*, by Gerlof Renooy; *An Index to Business Indices*, by D. H. Davenport and F. V. Scott; *Selected List of Current Foreign Financial Sources*, compiled by E. S. Cavanaugh and published by the Special Libraries Association; *Price Sources*, compiled by E. M. Carmack and issued as an United States Department of Commerce publication; and "Footnotes on Time Series," on pp. 165–238 in the 1940 *Supplement to the Survey of Current Business* and comparable bibliographies in previous issues of this Supplement.

So far as I have been able to discover three attempts have been made to provide something resembling an index to census publications. These are the *Circular of Information Concerning Census Publications 1790–1916*, issued as one of a series of five circulars, "for the purpose of giving the public a better and clearer understanding of the work of the Census Bureau;" the studies made by L. F. Schmeckebier and published by The Institute for Government Research and The Brookings Institution; and the *Topical Index of Population Census Reports 1900–1930*, made up at the solicitation of the Committee on Social Statistics of the Social Science Research Council.

It is unfortunately true that the existence of even these tools is not very generally known and that the most frequent plea of librarians and others using census figures is, "If there were only an index or some explanation of what can be found in the census reports, of what is given one year and omitted in another, what a real contribution to research tools that would be!" More often than not answers to questions put to the library are wanted the "day before yesterday." For this reason we would put as a necessary "first" adequate indexing and/or detailed contents pages in one place.

When one realizes the great amount of tax money spent to gather such an invaluable storehouse of data, does it not seem just ordinarily sensible to supply it with a key that will truly unlock its contents? In hundreds of instances guesses are made concerning problems covered by census publications when facts are available which are not located because of inadequate indexing.

Librarians are not alone in voicing this need. Social workers and statisticians in numerous fields frequently have expressed the need of making available through an index not only the published but also the

unpublished data collected and on hand in the Bureau of the Census.[5] Recently, a man engaged in research for an advertising agency said to one of our assistants, "Funny, the Census of Manufactures gives data on piano parts but not on pianos, which happen to be what I need right now." That did seem queer! So we looked through the index again. Sure enough piano parts are listed but not pianos. At the end of the index under "Miscellaneous—Musical Instruments—Pianos," were most of the facts needed for the particular problem at hand.

If indexing must be held up a while longer there is still a way to make the data more readily available. This would be to provide an analytical table of contents. At present a number of census volumes have a main contents page which eliminates all detail and requires the user to turn to the second contents page where the tables are listed in greater detail. Is there any good reason why an analytical table of contents cannot be given when tables of contents usually are given in books? Much time would thus be saved in determining which tables give the needed figures or in proving that they are not given at all.

The next problem that has presented itself in the use of census data is the result of a re-classification of information, and omission of certain items from one report which had been included in previous reports.

A university professor on leave to do special work for the Temporary National Economic Committee, has been using Census of Manufactures figures for authentic data on comparative productivity per worker in a number of specific industries over a period of years.

Through 1937, the Census of Manufactures indicates the number of employees in the various manufacturing industries by *industry*, regardless of their particular activity in the industry. In 1939, however, for the first time, employees primarily engaged in distribution or construction activities in the manufacturing industries are reported separately.

Although we know there is increased productivity per worker due to technological developments continuously taking place, our professor's report will have more weight if his figures are on a comparative basis. No doubt the final reports will make it possible to bring these data together but until then there is this gap in the information.

Another problem relating to Census of Manufactures data occurred recently in connection with power laundries. A market analysis for a certain piece of equipment was being discussed and data on power laundries were needed. The market analyst came to us and said, "The

[5] Johnston, Mary, "The Need for an Index for Social Data," this JOURNAL, Vol. 24, no. 168, December 1929, pp. 398–404.

Fry, C. Luther, "Making Use of Census Data," this JOURNAL, Vol. 25, no. 170, June 1930, pp. 130–138.

Census of Manufactures is supposed to include power laundries. I've gone through this volume till I'm dizzy but cannot find it." Fortunately the Marketing Research Division of the Bureau of Foreign and Domestic Commerce in its abstract of the Power Laundries' report clarified the situation by its definite statement: "The Power Laundry is canvassed biennially in connection with the Census of Manufactures but the statistics gathered are not included in the census totals for manufacturing industries." You can see readily how useful it would have been to have had a reference to that effect printed in the volume on manufacturing industries.

Not a day passes by that some reader does not hopefully request figures in a form other than that given. For instance, "How many people in the United States live in towns of 20,000 or less in population?" and "What is the average annual wage in the public utility field in age groups 18–25, 25–30, 30–40, 40–50, and over 50?" Each of these questions concerned social and economic developments. In the first case, the client was trying to find out whether the drift of population was away from large centers and into smaller communities. In the other case, a personnel department was working on a pension plan for employees and needed some sort of barometer for determining trend of wages and salaries according to age.

This question of average annual earnings for individuals occurs frequently in various forms and the payroll data as now collected do not serve the purpose. Linda H. Morley of Industrial Relations Counselors, Inc., with whom I discussed this paper, epitomized this need in saying, "From the point of view of industrial relations the amount earned by the average individual is more significant than the amount paid out in wages."

Other questions, answers to which were very important to those who asked them, but which could not be answered from the data as now published were:

How many firms in Cleveland employ 10 to 25 people and how many employ 25 to 50 people?

How many people are employed as clerical workers by trade associations and by labor unions?

How many retail clerks are engaged in selling women's ready to wear clothing?

How much gasoline was consumed in Ohio, Pennsylvania, New York, Michigan and California, by counties?

Number of different types of heating units by census tracts for cities other than Cleveland?

How many lithographers designing labels are employed in factories making tin cans?

How many skilled and semi-skilled laborers over 40 years of age are employed by the machine tool industry?

How much capital is invested in the productive industries? (Figures are available on *capital invested* for the State of Pennsylvania from that state's Department of Internal Affairs, but to date we have not located similar data for other states.)

In conclusion, may I summarize a few needs indicated in this paper for better use of census data in libraries:

1. Adequate indexing.
2. Better tables of contents.
3. An outline of what is covered by the various census publications; e.g. Hand laundries are covered by the Census of Business while data for power laundries are collected biennially with the Census of Manufactures but these are published in a separate report; County figures may be given for some years and not for others.
4. Gathering of information on labor organizations, trade associations, social agencies and other service groups.
5. Grouping of companies by number of employees or other indication of size.
6. Adding *capital invested* for industries to Census of Manufactures.
7. Provide a breakdown of employees in Census of Manufactures according to skilled, and semi-skilled workers.

There is a much needed greater break-down for occupations, but this has already been discussed before this Association[6] and we await with great interest the 1940 report on occupations, which we have been told, will incorporate "The Convertibility List of Occupations by Major Groups," which was developed by The Committee on Occupational Classification of the Central Statistical Board and The American Statistical Association.

[6] Palmer, Gladys L., "The Convertibility List of Occupations and the Problems of Developing It," this JOURNAL, Vol. 34, No. 208, December 1939, pp. 693–708.

HOW A NEWSPAPERMAN LIKES STATISTICS PRESENTED*

By John W. Love, *Business Editor*
The Cleveland Press

As a journalist in these days I am necessarily a consumer of statistics. It is perhaps fitting that with the rise of consumerism in recent years, the middlemen and ultimate customers of statistical output should have greater recognition in the market.

There may not be half a dozen members of the American Statistical Association who like myself are solely consumers, producing or processing no statistics of our own but using only the work of others. I do not even print statistics in my business column in the newspaper any more than I can avoid, but I must habitually employ them in its preparation.

Although some of my best friends are statisticians I might remark that I think their product should be kept in its proper place, as inconspicuous as possible, so far as the public is concerned. Most consumers, I regret to admit, use statistics mainly to prove ideas they possess before they look for the evidence. This fault has even been detected in newspapers, I have been told, though it is probably less often noticed on the financial pages than on some others. It may be that no small share of our difficulties of these times has been due to the rise of technological improvement in statistics without a corresponding growth of wisdom in their presentation.

I have heard newspaper editors say the public was not interested in statistics, and I know of one editorial writer who lost his job because his work was "too statistical," according to the editor. The fact is, however, that the newspaper public has been consuming large quantities of statistics for decades—on the financial and sports pages. One great editor was himself so interested in statistics, though always as a layman or consumer, that he endowed the Scripps Foundation for Population Research.

The quantity of statistics is now so great that we ought to be devoting more thought to its packaging. Industrial statisticians, one notices, now admit the existence of the problem of getting the company presidents and vice presidents to read what they produce. It is pathetic but true that corporations will spend many thousands of dollars in statistical research and sometimes nobody but the statistician will read what he turns out. In years to come statisticians may reach the point of being

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

able to discuss openly how to induce executives not only to read the product but to base their action upon it.

One of the oldest sources of the statistics consumed by the public has been the Census Bureau. Evidently the Directors of the Census many years ago saw the value to the public of presenting their information in standard form, varying little from census period to census period. Decade after decade the press releases and the subsequent publications carry the information in the same language and in the same places in the tables. Whatever may be said from the statistician's point of view concerning the dangers of such standardization, the newspaper man is likely to assert the value of the rigidity of form. It facilitates comparison.

There are, no doubt, plenty of instances where lack of initiative on the part of issuing agencies and their unwillingness to change forms have prevented our getting information we have long needed, and I suspect the habits of journalists are to a degree responsible for the reluctance to change. At a time like the present, when a quantity of material is coming from the Census Bureau, the user soon learns the style of the page of preliminary or press release, and this familiarity aids him in its interpretation. I suppose the statistician needs to keep in mind the value of modernizing his material at the same time he maintains as much comparability as possible, requirements that would often call for ingenious adaptation.

We have in Cleveland a monthly report of employment in 100 large factories, compiled by the statistician of the Chamber of Commerce. This report has followed almost the same form since 1921. Its extreme standardization is one of the merits which have gained for it a steadily greater interest. Probably twenty different newspaper men handle it in the course of a year, but mistakes are almost never made in its interpretation because so many are now familiar with it.

Most census material which reaches the public initially is carried on the wire services from Washington, and the problem of statistical presentation on these first announcements is the simple one of suiting it to the uses of three or four press organizations. There follow by mail the summaries of preliminary information. Some of them are printed on one side of the paper and their tables can be cut and pasted into articles. The releases are not written directly for publication, however, and I think that is to be commended. Most newspapers rewrite what comes to them by mail anyway, and the practice which some organizations follow of trying to put their statistical material directly into article form and newspaper language I think is often unnecessary.

The office of the Secretary of Labor in Washington might well learn something from the Census Bureau in regard to the presentation of statistical facts. Each month Miss Perkins gives out to the newspapers a lengthy report on employment. Unlike the press releases of the Census Bureau this statement carries no title. One must read the first paragraph to discover what it is about. It is written in such a way that it can be sent directly to the printer, after adding a headline, but it is multigraphed on both sides of the sheet. It quotes the Secretary directly for a page or more, then drops the quotes. The use of the quotation marks, as well as some items of newspaper style, makes one suppose the compiler thinks the newspapers will use it directly for printer's copy, and yet the fact he economically employs both sides of the page makes it clear he does not.

Before the reader gets even a little way into this long statement of increases and decreases of employment by localities and industries he realizes that it is something from which readers are expected to extract the material they can use. Many offices might therefore wish to file it, but the foolscap length makes folding necessary in most office files. The length of the tables apparently dictates the length of the pages, but the Census Bureau resolves this little dilemma by reducing the size of the typewriter type by what I suppose is the planotype process. One of the beauties of the census releases is their standard size, fitting neatly into a letter-size folder.

The releases of the Census of Manufactures follow a form which has been similarly standardized and is suitable either for publication directly (in part) or for filing. I could wish the Census of Manufactures would report separately the industries by counties, in addition to cities, instead of those reports for what are called "industrial" districts. Just how some of these industrial districts are selected it is hard for me to see, and for the one with which I have the most experience—that consisting in the census reports of Cuyahoga and Lorain Counties in Ohio—the grouping is all but useless. The trouble with separately reporting the industries both by cities and counties would be, of course, that many concerns in the suburbs of the principal city would have their operations disclosed by mere subtraction. Even so, it is questionable whether some of these so-called industrial districts are worth the effort of their assembling.

The Census of Distribution is a service whose value the newspapers and the public are yet to appreciate in full. Even the statistical departments in the business offices of newspapers do not use its reports as much as they should. Perhaps there is room here for some public-rela-

tions work on the part of the Bureau. I suspect the Bureau could add to the value of this facility by computing and publishing more ratios. Business men, as we all know, employ many ratios in their work, and if national, state and city ratios could be computed for the separate lines of business they would save the user a good deal of figuring. The ratios of special interest to retailers obviously would be those of operating expense to sales and of payroll to sales or to operating expense. I believe the Census of Wholesale Distribution uses a ratio of operating expense to sales, and the same could profitably be extended for the Census of Retail Distribution. Making these ratios available and giving publicity to their presence might increase the demand for the material.

Some of the newer agencies of the Government have not had the same reverence the Census Bureau possesses for the more austere canons of statistical presentation. Even a layman's respect for government statistical work may suffer when he examines a report like that on Consumer Incomes in the United States, published two years ago, and discovers that incomes are distinguished first by tenths of the population then by thirds, and again by tenths, and finds, moreover, that the three-thirds of the Nation first include those receiving relief and then the nonrelief families alone, and finally that the categories into which the three-thirds are divided for statistical analysis are not the same as those into which the ten-tenths are divided. The writer of the report on Consumer Incomes had to admit that averages of incomes did not mean much for the top third of the Nation, and that as between country and city life the dollar figures do not give a true picture of variations of income among the American people. The inclusion of these admissions was to have been commended, of course, but the reader of the report had to suspect the use of so unusual à segregation of data as in national *thirds* was due mainly to the fact that President Roosevelt had chosen not long before to allude to the one-third who were ill-clothed and ill-housed. The effect of this report was clouded by the suspicion it had been brought out to prove something.

A good many producers of statistics seem to think it is important to have their material rewritten into newspaper language before it is offered to the newspapers. They go to the expense of hiring publicity men to write what we call "leads" on some of the simplest of statistical announcements. Practices differ within the same organization. For example, General Motors regularly issues from its Broadway office in New York a tabulation of the General Motors-Cornell weekly index of commodity prices. It consists of nothing but the title and a table. That is enough. Other material comes to the financial desk of a news-

paper from the same corporation with long explanation of what the figures mean.

I am inclined to doubt the value of much of the rewriting which some statisticians seem to think is necessary. A summary is valuable, of course, when the work runs to considerable length. Perhaps if statisticians could be sure their product went to the same persons month after month they would not undertake it. Some inquiry on their part as to who customarily receives the material might be useful.

I have long admired the simple and clear form in which Stanley Hunt's Textile Economics Bureau presented its figures on monthly shipments of rayon yarn, and thought he was one statistician who knew what newspapers wanted and did not go to the trouble of dolling it up for us. I wrote him, and learned to my surprise that he has a publicity man take his monthly figures and write a short article about them. This is Mr. Hunt's explanation:

> I think it is probably true that the typical statistician-research worker approaches his writing on the basis of developing several facts and working from these facts to a conclusion. In most instances the conclusion is stated at the end of his article or paper.
>
> On the other hand (I should be telling you), the newspaper story starts out with the most important conclusions and "works backward" so to speak. While I am fully aware of this newspaper technique, I find it difficult to put into practice. On the other hand, a regular newspaper man can do this very easily.
>
> A second point involved, in our case at least, is the fact that here at the bureau we get mistaken ideas about just what news is. We sometimes become so engrossed in our writing here that we probably do not have the proper perspective on the newsworthiness of a given article.

Perhaps there is indeed a subdivision of the art of journalism in the handling of statistical material, and perhaps there is a small field for the statistical journalist. There may be a division, even an antithesis, between the ability to derive statistical truth and the ability to present it in an interesting manner. Be that as it may, I suspect that statisticians would pick up the rudiments of the art with little trouble.

Would it not be possible for some of them, if they desire publicity, to apply their own statistical method of sampling to the question of what newspapers and other publications want? By trying various methods of presentation and then comparing the clippings from each venture it would not take them long to see which ones are most effective.

The effort on the part of statisticians to make their product "popular" has its pitfalls. Some of them undertake it, even in government service, as if the tenure of their jobs depended on the number of times

the office was publicly mentioned. Many do in private work, or their employers do, seeing in their material the means of obtaining favorable "institutional" publicity. Properly handled, these releases may be thoroughly worth the effort, but the suspicion that the figures are being prettied up for publication is easily aroused. It would be much better, I am sure, to give out the information in its raw form with a few words of explanation than to attempt an exposition at a length which might inadvertently make it clear to the prospective user that the statistician's purpose was not the scholarly disclosure of truth but the hope of getting free advertising.

Some of the most egregious errors all along the line, from the derivation of statistical material to its public presentation, are made by officers of taxpayers' committees which have sprung up in recent years. The field of their activity is in considerable part statistical, and a clear and forceful presentation of their case is imperative. Data on public expenditures are necessarily difficult and dull, and extraordinary effort is needed to make them readable. But if the information is inaccurate in the first place, as it sometimes is, readability may have a negative value. I could almost call it the civic duty of people in the statistical profession to warn the inexperienced backers of such organizations against the dangers of using untrained people.

This work, important in many communities, is most likely to be carried out properly if it is entrusted to well-established civic organizations which expect to be in business a long time, and to men who know the statistical profession in the field and can call on its members for advice.

Something probably ought to be said from the consumer's point of view concerning the use of charts, but the literature in that field is pretty large. For newspaper purposes the simpler the chart the better, as a rule, not merely because the reader's ability to use a chart is pretty close to that of the average man, but because few newspapers can afford to employ specialized draftsmen of charts. They often dislike to publish material which newspaper readers see at a glance came from outside the newspaper office.

It is not personal preference alone which leads me to say it is wise to use as few statistics or statistical tables as possible in the running statements of an article, and then separately to group the evidence either in tables or charts or both. This is emphatically best for newspaper publication because of the difficulties of making up into columns an article which includes tables as part of the running text.

Colonel Leonard P. Ayres' Monthly Bulletin of the Cleveland Trust Company seldom has figures in the text, even writes out dollar figures

in words, and practically never carries any tables. The evidence to support the statements made therein is carried in the charts, and the charts are clearly labelled and the sources of their information are always given. A part of the public following of that Bulletin has been built on the ability of the general reader to follow it clearly.

Tables of figures may be used in certain articles for general publication, of course, but even in this Journal I like those articles best which state the conclusions the writer is drawing from the statistical material which is presented separately. The tables may be printed in the body of the article, to be sure, taking elementary care to number the table and cite it at the proper place. Even the headings of the tables, as well as the headings of the charts, might well make it clear what they are intended to present. The reader of that kind of article can derive some of the meaning merely by looking at the charts, or at the headings of the tables, or he may read the article and never examine the tables, taking the writer's word for it that the tables support his conclusions. This method may result, of course, in the writer telling his story twice or even three times, but is this to be deplored?

I was discussing this point with Whiting Williams, the industrial relations consultant. He said statistical writers can seldom go wrong, he thought, in telling the same thing in many different ways, at least if they are writing for the layman. Too often, he thought, statisticians seemed to believe that because they had gone to a lot of work, the reader ought to do the same.

People who undertake to present statistical truths to industrial workers in large numbers need especially to be wary of double risks—those on the one hand of confusing the readers or making it difficult for them, and on the other of seeming to write down to them. The device of presenting the statistical evidence separately, for those who want to go farther into the reasons the writer thinks as he does, is probably a good one to follow in that type of communication.

In conclusion I cite what a friend of mine in Chicago wrote me, a man who is with one of the largest corporations there:

> Like yourself, we are not statisticians but we are frequently called upon to interpret statistics. We try to approach our interpretations with two distinct objectives in mind: one, that the statistics must be fundamentally honest and sound, and, two, they must be presented in such a way as to be understandable by the general public. It seems to me that unless statistics meet both of these requirements they are not only useless but tend to spread misinformation and confuse the thinking of the people, defeating the very purpose of clarification and understanding which statistics should promote.

PROBLEMS CONCERNING THE AVAILABILITY OF CENSUS DATA*

By Halbert L. Dunn, M.D., *Chief Statistician for Vital Statistics*
United States Bureau of the Census

A few weeks ago I saw an animated cartoon called "Willie the Flea." Willie, a brisk businesslike little chap, was looking for a new home. With his worldly possessions wrapped in a red bandana handkerchief and slung over his shoulder, he entered a large estate, marched to the huge front door, scrambled through a crack beneath it, and then spied the family hound asleep by the fire. With a gleeful hop, skip and jump, he landed squarely on his goal and sank beneath the protective surface of soft white hair.

From this time on, the film was a play between two viewpoints—that of the dog who awoke with a start from his sleep, knowing that something uncomfortable was happening to him, and that of the flea who in an objective sort of way busied himself to insure his comfort. The thought startled me as I sat fascinated, watching Willie wander between huge shiny tree trunks, which were magnified dog hairs, that while I had observed many times the bizarre scratchings of a dog with a flea, I had never before considered the state of affairs from the flea's standpoint.

Understanding is a fragile tie at best. Too often we say we understand when actually what we do is observe. We put our Willie under the microscope instead of imagining how we would feel if we were a flea with a flea's outlook on life. Occasionally, while writing a difficult letter, I have taken the final draft to a colleague and said, "Pretend that you are Mr. So-and-so, crusty of disposition, with a grudge against the Federal Government and a particular dislike to vital statistics and tell me how you would react to this letter." This little game of make-believe pays dividends in understanding.

The problems involved with making census data available to the public are primarily psychological ones—largely involved with understanding the other chap's viewpoint. True, there are plenty of headaches in terms of budget, publication, analysis, and presentation of statistical material. But these things can be solved by buying trained brains and skilled hands, by turning them loose to do a job the best they can. But to understand the audience for this material is a more difficult matter—one which is hemmed in by barriers of ignorance, indifference, distance, and prejudice. If the Bureau is to reach its audience

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 27, 1940.

and make its data truly available, its primary task is to understand the people whom it would serve, and whose needs it desires to satisfy. It must interpret its data in the light of what *they* are. Of how *they* live and feel and dream. In no other way can the gap be bridged between supply and demand.

The Bureau's difficulty arises from the variability of its audience. Most agencies publishing statistics would at least have a subject matter field in common with specific interests of the people whom it sought to serve. The subject matter field of the Census Bureau is the American people; of all ages and races; of both sexes; of every degree of education and intelligence; of every type of social interest; of every variety of occupational specialization. All types of organizations with their special needs are represented.

To fill the needs of such a varied audience, the Bureau has available tabulations on many subjects such as: Population and citizenship, schooling and illiteracy, occupations and employment, family and housing, business and manufacturing, taxation and agriculture. The Division of Vital Statistics is attempting to serve a public which is almost as variable. However, the Division benefits by more sharply defined fields of interest in its audience, particularly those relating to public health and social security. The needs can be largely answered by data on birth and death, sickness, marriage, divorce, fertility, and hospitalization.

Let us consider the users of census data. Let us try to understand *their* needs for factual information in the way that *they* would express it.

Everyday life varies from community to community. The interests and outlook of the Kentucky mountaineer differ considerably from the blue grass country gentleman. The Negro of Mississippi is not the Negro of Chicago. The rancher from Colorado could well be the citizen of a foreign country to the farmer from Maine. A youth of seventeen has everything before him—the feeble man of eighty, everything behind. The youth seeks opportunity; the aged, security and peace.

These considerations bring with them the conclusion that census data must be assembled in small packages, containing information suitable to the particular interests of those types of persons who will probably use them. In the Division of Vital Statistics, we have experimented with the possibility of publishing our data in just such small packages suitable for satisfying especial interests.

In January 1936, the Vital Statistics-Special Reports series was established. By means of this series it became possible for us to publish statistics from six to nine months earlier than ever before and at the

same time to tailor-make publications of such statistics to fit the needs of special groups. By a survey of all requests coming to the Division new releases were planned which would answer the practical questions contained in letters and queries.

A few of the principal advances arising from the requests coming to the Division are:

a) An analytical study conducted to evaluate the accuracy of current natality and mortality statistics. On the basis of this study, the reporting procedures for the Monthly Vital Statistics Bulletin were redrafted in order to improve the accuracy of current information on births and deaths.

b) Analytical studies of motor-vehicle accident fatalities made to determine the difference between accident statistics tabulated by place of death and by place of accident. This has resulted in a new reporting system for motor-vehicle accidents.

c) Increased usefulness of current reports, Weekly Health Index, Weekly Accident Bulletin, and the Monthly Vital Statistics Bulletin by the inclusion of rates for 1941. For the first time, it is possible to compare current vital data for the various cities or states.

d) Revision of State Summaries for 1939 to include additional tabulation and also a brief analytical abstract to highlight the interesting vital facts for the state. The 1940 State Summaries will probably be further revised so as to contain more data based on rates than ever before.

e) Increased number of releases on special subjects; cancer, pneumonia, tuberculosis, accidents, infant mortality, maternal mortality, etc., published in the Vital Statistics Special Reports series. This type of release makes data available about a year before they could be published in annual volumes, and makes for wider distribution.

f) Consolidation of all available statistical information on certain selected causes of death to be made available in 1941 as four-page releases.

g) Plans for county releases in which basic information relating to vital statistics and pertinent socio-economic data will be given.

h) Preparation in non-technical language of publications dealing with vital statistics.

i) Increased use of graphic methods in presenting data.

j) Efforts to improve appearance of reports by use of new format, varityper, layout, etc.

k) Devotion of much time and effort to the preparation of material in answer to requests.

l) Use of requests received to determine the publication of what data can best fill "popular" requests.

m) Critical review of our own publications.

n) Organization of our mailing list so as to serve more fully those groups having special interests.

The tailor-making of vital statistics publications for public need is still in the planning stage. Even so, we hear not infrequently the question from some scientist or public health leader, "How do you manage to publish in your series just exactly those tables which contain the answers I want to know?" Our reply, of course, is "You have built these tables yourself. Rarely does a new tabulation find its way into the series that does not arise from your practical questions."

To analyze requests for data from incoming letters is not enough. Rarely does one question in a hundred, formulated in the mind of the citizen, become crystallized in letter form. Not one need for statistical data in a hundred materializes in form so concrete that it can be consciously expressed by a verbal question. To understand the need, we must think and live the thoughts of those whom we serve.

An analysis of the "best sellers" in the Government list of publications shows that they have certain characteristics in common. Most of them are handbooks or guides to some important problem which people face. "Infant Care," published by the Children's Bureau, is an excellent example. Over 12,000,000 copies have been distributed. Why? Because the pamphlet is well written and packs a lot of information in a convenient form so that health workers, doctors, and nurses prescribe it as they would a bottle of medicine.

The Division of Vital Statistics has been experimenting in redesigning not only its statistical reports, but also its entire field of approach to the general public. Faced with the problem of a serious under-registration of births in the rural communities and possessed of a total field staff of just four people, there was no alternative to surrender, except complete reorientation of the field techniques. The decision was to try out a registration campaign which was completely integrated with community interests. The state selected for the original trial was West Virginia; the time chosen the first week in October 1938. Preparation went on for three months prior to the campaign. All state organizations were studied which ramified in their structural design from state to county sub-units. These organizations included parent teachers' associations, health departments, medical societies, women's clubs, American Legion posts, churches, etc. Talks and lectures on birth registration to fit each type of audience were prepared. The one to a mixed farm

	Tabulation	Cards Included	Geographic Location							Cause of Death			
				Population Groups									
			Selected States for race breakdown	Cities of 10,000+, Rural	Cities of 100,000+, 10,000+, 2,500+, Rural	Cities of 100,000+, 25,000+, 10,000+, 2,500+, Rural	Each County or City of 10,000+	Individual 100,000+ Cities	Selected 100,000+ Cities for race breakdown	Detailed List with Letter Subdivisions	Detailed List with Letter Combinations	Selected Causes[1]	Infant Cause List
Place of Death	1	Each State		1			a						
	2	Each State				3							
	3	Each State				a		b		1			
	4	Each State									1		
	5	Each State										1	
	6	Each State—Infant deaths		1			a						
	7	Each State—Infant deaths			b			d					1
	8	Each State—Non-resident deaths		1			a						
Place of Residence	9	Each State—Non-resident deaths		1			a						
	10	Each State				a						1	
	11	Each State—Cities of 10,000 to 100,000	1				a					2	
	12	Each State—Rural and rural cities	1				a					2	
	13	Each State—Cities of 100,000+						1	2			3	
	14	Each State	3	1			a						
	15	Each State—Infant deaths			b			d					1
	16	United States—Exclusive of white persons									2		

[1] There are two Selected Cause lists, one used for Tabulation 5, and the other, differing in causes included, for Tabulations 10, 11, 12, 13.

Note.—Sorts are indicated by numbers in order—1, 2, 3, etc. and counts by letters in order—a, b, c, etc. In each tabulation all *numbered* subjects are crossed with each other and with all *lettered* subjects; *lettered* subjects are not crossed with each other except where the same letter appears for two subjects, but are crossed with all numbered subjects. More than one sort or count or a sort and a count for any one subject are indicated by the appropriate combination of numbers and/or letters in the corresponding cell.

group started with the sentence, "Nearly all farmers realize the value of well-bred livestock," and then went on to link birth registration to the registration of pure-bred stock. The campaign plan included in its list of talks a sermon incorporating registration facts gleaned from the Bible. This was preached from scores of pulpits. State leaders were urged to give all credit for the campaign to county leaders.

Was the campaign successful? It swamped the State Health Depart-

TABULATIONS 1939

Age			Race and Nativity						Sex	Institution			Marital Condition	Month of Death
Under 1 yr., 1–4 yrs., 10 yr. age groups to 84, 85+, unk.	Under 1 year, single years to 4, 5 yr. age groups to 99,100+, unk.	Infant: Under 1 day, 1, 2, 3–6, 7–13, 14–20, 21–29 days, 1, 2 . . . 11 mos.	White, Other	White, Negro, Other	White nativity, Negro, Indian, Chinese, Japanese, Other	Other (excl. White)	Negro, Other (excl. White)	Negro, Indian, Chinese, Japanese, Other (excl. White)	Male, Female	No institution, Nonresident institution, Resident institution	Type of institution, in detail	Type of control, in detail	Single, Married, Widowed, Divorced, Unknown	
				3						2				
	a				2				1		c	d	e	b
				a, b					2					
	a, c		b			c		d	2					
	a		2						3		c	d	e	b
				2										
		2	b, d	a					a					c
				3						2				
				3						2				
				a					2					
			1						3					
			1						3					
	a		2						4		c	d	e	b
2			3											
		2	b, d	a					a					c
	a						1		3					b

ment for months with requests for checking and registration. It left the State seeded in almost every county with prominent citizens who were interested in the subject. Their interest arose because they had participated—because the entire county effort had been credited to their leadership.

One of the lessons learned from this campaign and others of kindred nature was the tremendous local interest in everything which concerns one's own city and one's own county. Most national organizations of any great strength ramify through state branches into county or city chapters or societies. The consequence is that local interest in all facts

about one's own county is something in which practically everyone participates.

For instance, I recall how surprised we were several years ago when we observed that two shaded county maps of the birth and death rates from the State of Texas "stole the show" from other Census Bureau exhibits. We would have rated the maps among the least interesting of all the Bureau's exhibits. However, the demonstrator told us that almost every person coming to the booth immediately looked on the map so as to locate his county and determine its relative standing with other counties or with the state as a whole.

Because the Bureau of the Census has come to realize the importance of this interest in county data, it plans and hopes to be able to issue county releases which will include the principal results for the 1940 Sixteenth Decennial Census. Such county leaflets will permit a wide popular distribution of the census totals and other information most frequently requested, and at the same time should reduce the use of the more expensive bulletins and volumes. The leaflets could be purchased in bulk at insignificant cost from the Superintendent of Documents for use in local conventions, schools, and other groups and institutions. They will probably be used extensively by county officials, agricultural agents, and other persons interested in civic affairs, and by persons wishing to have the standard-list items for large areas including many counties, such as the Ozark region, the Mississippi delta, or the TVA area.

To accompany the county leaflet series, it is planned to have a small United States pamphlet carrying the identical stubs used in the county leaflets, and giving such data for the United States as a whole and for each state.

It is realized that these releases will be but a first step in making Census data available psychologically as well as physically to the American public. A score of other types of tabulations are needed almost as urgently.

One request which reappears time and again in the letters of the Division of Vital Statistics is the need for a simple index which will show what data are in existence. This request assumes particular importance when one realizes that a very small fraction of the data attainable in tabulations is ever reduced to printed tables for publication. Only the tabulations which seem to be the most important can be published by the Bureau.

The Division of Vital Statistics has experimented with algebraic methods of indicating what is available in its original machine tabula-

tions, its volumes, its special report series, and its unpublished tables. An unusually high concentration in the index can be achieved by the algebraic method.[1]

The Division expects to publish algebraic content indices such as these each year for the data which are available. Later, it hopes to index all data which it has published at any time.

[1] The basic principle of this index is that a number under an item means that that item is crossed with every other item in the tabulation, while a letter signifies that it is crossed only with all numbered items. The mortality tabulations of 1939 are reproduced in the table. These involve almost 20,000 sheets of data. Tabulation No. 7 is by place of death. Each category of the entire infant death cause list, about fifty in number, is tabulated for the infant age breakdown of under 1 day, 1 day, 2 days, 3–6 days, 7–13 days, etc. Each of these breakdowns in turn is tabulated (1) by urban and rural population groups crossed with race (white and "other"), (2) by individual 100,000 cities crossed with race (white and other), (3) by race (white, Negro, and other) crossed with sex, and (4) by month of death. The (b, d) under race (white and other) indicates that the information for individual cities and for population groups is also broken down for white and other races. The (a) under the race item (white, Negro, and other) and under the sex item indicates that these items are cross tabulated.

OBSERVATION ON CORRELATION ANALYSIS

By A. H. Mowbray, *University of California*

The recent controversy between Messrs. Malenbaum and Black, on the one hand, and Messrs. Bean and Ezekiel, on the other, over the use of the short-cut graphic method of multiple correlation[1] seems to have closed without agreement on definitive principles by which investigators may be safely guided in the use of such a method, and there has been introduced through a footnote an implied approval of the assumption that true regression surfaces may be found from "samples which are not random and are taken from a universe the independent factors in which may be changing from observation to observation."[2] This situation may be an indication that in the rapid extention of the use of correlation analysis and the development of alternative techniques, there has been a tendency to forget or ignore the fundamental definitions and assumptions of correlation analysis and the limitations following therefrom. It is the purpose of these notes to hark back to those fundamentals to see if from them rules or tests may not be developed which may serve as safe guides in the use of the newer techniques.

The concept of correlation analysis from which we begin is that it is an aspect of logical induction, a means of testing hypotheses. We draw a distinction between an hypothesis and an empirical generalization, in that the former is susceptible of explanation or rational interpretation in the light of already established facts and relations and the latter is merely a generalized statement of observational results. An empirical generalization may lead to hypothesis or it may not. An empirical statement, especially if graphic, may be so particularized as to lose generality and yet in such a way that only test on a broader basis will establish the loss of generality. Particularization of an hypothesis which must be expressed in words or symbols tends to expose itself immediately by its necessary elaborateness exactly to describe its particular form. From these considerations, it would appear that the first requirement for validity of any correlation analysis is a rational explanation of its regression equation.

It is not necessary that the hypothesis be fully developed before the correlation study is begun. It is, of course, necessary that the variables presumed to be related be known so that associated values may be observed. But this is sufficient at the outset. The character of the association may be developed by the study.

[1] *Quarterly Journal of Economics*, LII, pp. 66–112, and LIV, pp. 318–364.
[2] *Ibid.*, LIV, 358.

It would seem, however, that if results are to be of any utility a logical explanation of the form of the regression expression, be it equation or curve, must be found. Otherwise, it would seem the result must stand as an *ad hoc* representation of a particular set of observations and of very doubtful, if any, application beyond that point, regardless of the numerical value of any correlation coefficient found. If no rational explanation of the form of regression can be found, what reason can be adduced for thinking another sample would yield a similar result? On what rational grounds may it be assumed that the regression found over the investigated range will obtain at any point beyond that range? In the absence of a logical explanation, generalization of the regression found would be a mere *ipse dixit.*

This seems to be a first general principle to guide the user of either "flexible" or "inflexible" methods of correlation analysis. Indeed, from this point of view the only difference between flexible and inflexible methods is that the former demands that the hypothesis be developed in advance or at least as curves are modified, the latter is willing to allow the best fit of lines (straight lines, second degree parabolas, etc.) to be found before working out the detail of hypothesis.

In the graphic method one should assume a range of possible regression curves or surfaces which logically may be expected to express the relationship existing between the several variables. Hypotheses corresponding to such curves or surfaces should be developed to explain the relationships represented and each curve or surface tested to show which best fits the available data.

If the data used are adequately representative of the universe (and only under this condition should it be used as a basis for generalization) it may be used to determine the particular curve or surface which gives the best reasonable explanation of the relationship.

What constitutes an adequate test of any hypothesis is a question not susceptible of precise answer. In the physical sciences even so-called "laws" are held as no more than working hypotheses or approximations to be abandoned or corrected as the weight of new evidence indicates. Even though not going so far as this, probably no careful investigator would give much credence to any hypothesis the test of which had been less extensive than that imposed by a random sample of the entire universe to which it pretended to apply. If the sample were small he would also demand consistent results when the sample is broken randomly into parts and each treated as an independent sample. Even under this test the degree of credence should be further restricted in accordance with the indications of the recognized

probability tests for chance errors. If there is no stable (within the limits of the hypothesis) universe by which it may be tested, what has the investigator or the student considering the hypothesis upon which to base a judgment? Can we accept the proposition that it may be tested by considering its application, in a correlation analysis of "samples which are not random and are taken from a universe the independent factors in which may be changing from observation to observation?" We think not. However much it may be desired to study such samples as particular economic or social problems, the correlation analysis, as a technique of testing hypotheses, hardly seems an appropriate tool. It is true that the mechanics of that analysis may be applied to such conditions but the results appear to be no more than abbreviated descriptions of the particular data. This, then, seems to be a second general principle suitable as a guide for the users of correlation analysis.

Tschuprow, in his *Principles of the Mathematical Theory of Correlation*[3] distinguishes sharply between "Stochastic connexion and functional relationship between variable magnitudes." By functional relation he means what is ordinarily referred to as a law, that is, a completely reversible statement of quantitative relation between the values of two or more variable magnitudes, so that all but one being given that one may be precisely determined. By stochastic connection, he means such a relation between the so-called "dependent" variable and the "independent" variables that when the latter are given, a frequency distribution of the former is found to correspond. The difference is between exact value and a range of values of varying degree of probability. The complete universe whose properties are sought by correlation analysis may be considered, *a priori*, as a joint frequency distribution, such as would arise from the superposition of chance perturbations upon the forces setting up a functional relation between a set of variables. The problem of correlation analysis is the approximate description of that *a priori* joint frequency distribution by the use of coefficients derived from an empirical sample, which coefficients correspond to the theoretical coefficients of the *a priori* distribution. Under this approach the regression line or surface is an approximation to the expression of an underlying functional relation, perturbation of which by a multiplicity of other forces gives rise to the joint frequency distribution. The joint frequency distribution will be of high or low dispersion depending upon the joint potency of the perturbing forces, its symmetry or skewness will depend upon their relative potency.

Geometrically, then, the regression expression may be thought of as defined by a shell or part of shell in n-dimensional space, and the theo-

[3] Translated by M. Kautorowitsch, Wm. Hodge & Co., London, 1939, Chap. III.

retical data described by the *a priori* joint frequency distribution as cloud of points distributed around this shell with decreasing density as the distance from the shell increases.

With this concept in mind we may turn to the fundamental equation of the correlation analysis, that for the coefficient of determination,[4] which in its most general form may be written:

$$\rho^2_{y.x}=1-\frac{S^2_y}{\sigma^2_y},$$

where σ^2_y has its usual meaning and S^2_y is the mean of the squares of the deviations of the observed values of y from the computed values, and ρ is used to indicate that curvilinear multiple relations are included.

It may first be noted that this equation presumes a "least squares" fit of the regression function, for otherwise by substituting such a fit a lower value of S^2 and higher ρ^2 could be found. In the ideal *a priori* joint frequency distribution the regression function passes through the mean of each array of the dependent variable. It may not do so as to the distribution of the observed data due to chance variation of limited numbers. In practice, as indicated by Bean and Ezekiel the minimizing of the squared residuals may be worked out by a trial and error approach, but this approach is subject to our first principle stated above that the regression expression must represent a rational hypothesis.

Although in the first stages of the development of correlation analysis it was assumed that the dependent variable must be normally distributed, that has been shown to be unnecessary. Indeed, if it were so, then the technique could not be used to analyze the variation of a variable whose relation to other variables was other than linear.

What may be said of the residuals whose mean square is S^2? Two cases may be considered. In the first it is assumed that the volume of data is practically unlimited. In that case it would appear that if the regression expression accounted for all systematic forces affecting the dependent variable, the residuals would form a normal distribution, not only as a whole, but in each array. For, if all the systematic forces are accounted for, then the remaining variation will be due to that complex of variable forces we subsume under the term "chance." Theoretical analysis and experimental observation seem to confirm each other that the variation so produced does tend to take the form of a normal distribution. If, with practically unlimited data, the distribution does not tend to be normal both externally and internally it would appear the analysis is incomplete. Either all the important forces influencing the

[4] From what has been said above it is probably evident that this writer regards the regression equation as the real fundamental equation. But this cannot be discussed further in general terms.

dependent variables have not been taken into account or the form of regression expression used does not correspond to the true underlying functional relation.

In the second case, where the data are limited, as Student and others have shown, it cannot always be expected that the residuals will tend to form a normal curve. It would appear, however, that not only should the sum of the residuals be zero, a concomitant of minimized squared residuals, but it should likewise be approximately zero for each array if the data are not broken into too fine classes. Any considerable piling up of residuals either positive or negative over considerable sections of the range should give rise to suspicion of an erroneous regression expression. This is probably most apt to appear when a rectilinear relation is assumed, for it is then one of the indicators of curvilinear relation.

At all times we may be guided by computation of error coefficients and their probability interpretation. If the sample is limited in volume and the chosen regression expression is complex the remaining degrees of freedom may be so few as to give a wide range of doubt for the acceptance of the regression expression.

Finally we may revert to Tschuprow's emphasis on the correlation analysis as a means of studying stochastic connection, i.e. functional relation modified by chance forces, and view the correlation coefficient or coefficient of determination from that point of view. If the data are not the result of such closely controlled experiment that chance variations are greatly reduced, too high a coefficient becomes suspect because it does not leave sufficient room for the play of the chance forces which, in the absence of such close control, our common experience tells us will be present.

To summarize: From the fundamental definitions and assumptions of the correlation technique it appears there may be deduced the following criteria for judging conclusions based on its use either by "flexible" or "inflexible" methods:

1. The reasonableness of the regression equation as a statement of relation in the sense of a working hypothesis or law as distinguished from an *ad hoc* descriptive expression of a particular situation.
2. The adequacy of the sample for the testing of an hypothesis, both as respects its size and the manner of its selection.
3. Within the limit of the first criterion, the approach of the squared residuals to a minimum.
4. The reasonableness of the distribution of the residuals as resultants of unconsidered forces.
5. The reasonableness of the measure of correlation in the light of what is known of possible effect of unconsidered forces.

CORPORATE EARNINGS ON SHARE AND BORROWED CAPITAL IN PERCENTAGES OF GROSS INCOME (1918–1940)

By Leland Rex Robinson*

In this journal for March, 1934, and again in September, 1936, there appeared articles under the same title whose charts and tables contained percentages of earnings for the entire period following World War I through 1932 and 1935 respectively. It is now possible to carry forward all of these figures through 1938 and some of them through 1940, thus giving us nearly a quarter-century view of the ability of American corporations to convert the "raw material" of their gross incomes into the "finished product" of earnings on capital, both borrowed and proprietary, utilized in business.

For a technical discussion of the statistical methods used, their advantages and limitations, and of other work in somewhat similar fields, the reader is referred to the earlier of these above-mentioned articles by the same author. Here the briefest recapitulation must suffice.

From the standpoint of the investor, the business man, and the banker the crucial question in connection with any undertaking is its capacity to convert gross income into net profit on capital employed. This capital includes both borrowed capital and share capital, and gross income comprises interest and dividends received and profit and loss turnover on securities owned, as well as revenues from ordinary operations. "Net profit" as used in Table I and the charts, differs from "net income" in the ordinary sense of earnings on share capital. "Net profit" as here employed is built up by adding to "net income" (after deduction of all taxes) all interest paid by the corporation on funded or unfunded debt.

It is evident that ratios of net profit to gross income (where net profit is taken as earnings, after taxes, on all capital employed, both borrowed and share, over the indicated period) are a more realistic gauge of business performance than are ratios of net income (taken as earnings on share capital only). With the former, changes in capital structure, such as alterations in proportions of borrowed and share capital, do not directly affect the ratios of earnings to gross income. With the latter these extraneous factors do have a direct and sometimes important effect upon such ratios from year to year. In other words, ratios of net profit to gross income would appear the better measure of business efficiency, considered of course from a purely acquisitive viewpoint.

* Note: The author has enjoyed the assistance of Florence Clark Beal of Washington, D.C., in the statistical compilations, and gratefully acknowledges her prompt and painstaking cooperation which has made possible going to press within a few days of the release of the 1938 Federal Statistics of Income.

TABLE

RATIOS (PER CENT) OF NET

	1918	1919	1920	1921	1922	1923	1924	1925
Total: All corporations†	6.5	6.5	4.0	0.1	5.1	5.3	4.5	5.3
Total: Representative corporations‡	9.5	8.5	7.9	2.6	8.4	9.0	8.7	10.0
Mining and petroleum: All	9.3	5.5	7.3	−4.0	4.1	2.8	2.0	7.5
Mining and petroleum: Representative	19.5	12.3	12.2	1.8	9.5	8.6	9.1	12.8
Total manufacturing: All	6.7	7.5	4.9	0.5	6.9	6.9	6.0	6.9
Total manufacturing: Representative	8.5	8.3	7.7	3.3	8.6	9.6	9.2	10.0
Food products, beverages and tobacco: All	4.2	3.6	2.3	1.1	4.4	4.7	4.5	4.0
Food products, beverages and tobacco: Representative	3.7	5.0	6.6	−1.5	8.6	10.3	10.3	8.6
Textiles and their products: All	6.4	9.6	3.1	2.5	7.1	6.7	2.7	4.5
Textiles and their products: Representative	10.7	12.0	9.7	7.0	7.2	9.1	2.3	3.8
Leather and its manufactures: All	5.4	8.4	−1.5	−2.5	5.0	3.0	3.3	3.5
Leather and its manufactures: Representative	7.9	7.3	3.3	5.0	9.1	7.7	8.7	8.6
Rubber products: All	7.4	8.8	0.3	−11.6	4.4	4.7	5.8	9.5
Rubber products: Representative	9.2	9.9	5.2	−13.9	7.9	7.1	9.4	10.7
Paper, pulp and products: All	6.7	9.0	10.0	0.4	6.3	7.4	6.4	7.5
Paper, pulp and products: Representative	....	....	....	4.7	11.4	15.3	10.5	11.0
Printing, publishing and allied industries: All	4.9	7.6	6.8	4.9	8.8	7.4	7.6	7.5
Printing, publishing and allied industries: Representative	−5.3	−3.2	2.2	9.6	6.9	7.8	6.4	7.8
Chemicals and allied products: All	6.5	7.8	5.5	1.3	9.3	7.7	8.6	10.2
Chemicals and allied products: Representative	7.0	8.8	9.8	6.4	15.4	15.5	12.1	12.4
Stone, clay and glass products: All	8.4	9.6	8.9	4.6	9.9	12.4	10.5	10.6
Stone, clay and glass products: Representative	....	....	29.7	11.3	11.8	14.4	20.2	22.4
Metals and their products: All	8.8	9.9	7.6	−1.4	7.6	7.9	7.4	8.3
Metals and their products: Representative	9.0	8.6	8.6	6.3	8.5	9.7	9.0	10.4
Trade: All	5.7	5.0	2.0	0.3	2.9	3.3	2.7	2.9
Trade: Representative	6.1	6.5	3.2	1.0	6.8	7.0	6.7	6.9

* Percentage of gross income available for interest and dividends after deduction of all taxes.

Net profit is used in the sense of earnings, after all operating and other costs and taxes, on all capital employed, including capital borrowed on long and short term. In other words, "net profit" as here used is equivalent to "net income" in the commonly employed sense (i.e. earnings on share capital) after deduction of taxes, with all interest paid added back in again. As proportions of borrowed capital vary from company to company, from group to group, and even from year to year, the ratios to gross income of net profit in this sense have more significance as a measure of efficiency and earning power than ratios based upon net income which is arbitrarily affected by changes in the volume and proportion of borrowed funds used in the business.

From another angle it seems wise not to omit such earnings as accrue to borrowed funds in computing the percentage of gross revenues coming through in the form of net. Only by taking earnings on all capital employed can the long-run capacity of enterprise to attract and wisely utilize savings be tested. To the extent that capitalization assumes the form of debt, net income on share capital alone must reflect the upward and downward leverage effects of prior lien fixed cost capital, thus distorting and magnifying any true picture of the ability of business to increase earnings during good times and its tendency to drop them during bad times.

Of course, earnings upon capital invested in the business are for this latter purpose a better indication than ratios of net to gross income. Capitalization, however, is sometimes as much a reflection of estab-

I

PROFIT TO GROSS INCOME*

1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1939§	1940§
5.3	4.6	5.3	5.6	2.5	−0.3	−2.8	1.3	2.7	3.6	4.4	4.1	2.2			
10.0	9.5	10.5	11.1	7.2	3.6	−0.7	4.3	5.7	7.1	8.6	8.0	5.0	7.3	7.9	7.6
8.8	4.3	7.1	9.1	2.8	−6.0	−7.5	−4.6	5.2	4.6	6.7	8.6	2.9			
12.8	7.8	13.0	15.6	7.2	−3.7	0.7	4.2	6.4	10.1	11.5	13.3	7.7	9.1	8.0	8.2
7.0	6.0	7.0	7.6	3.8	0.7	−2.7	2.3	3.6	5.3	6.1	5.6	3.1			
10.0	10.7	10.9	11.7	8.5	5.4	−2.5	5.1	6.1	7.7	9.5	8.2	4.9	8.0	8.3	7.9
4.6	4.2	4.6	4.8	4.2	3.2	2.5	3.9	4.5	4.5	4.7	3.3	3.4			
8.3	8.5	9.2	9.5	8.5	8.4	9.2	10.1	10.6	7.7	7.3	6.1	6.7	7.3	5.4	5.1
2.3	4.3	3.2	2.6	−3.1	−4.0	−6.4	2.7	0.8	1.6	3.1	1.7	−0.2			
6.4	8.4	8.7	7.5	−1.1	−0.7	−9.0	6.0	1.4	1.7	4.6	1.9	−2.9	4.0	2.8	2.1
3.2	4.6	3.4	2.7	−1.2	−2.6	−4.5	2.7	2.0	3.3	2.6	1.6	0.6			
7.7	9.7	8.7	8.4	7.3	7.1	5.6	7.4	6.6	6.3	6.2	4.6	3.4	4.9	4.9	4.8
4.6	5.5	2.0	3.4	−1.5	0.0	−1.9	2.8	4.4	4.2	5.4	4.2	3.2			
5.0	8.9	2.3	5.8	−0.2	1.4	−0.3	5.1	4.6	4.5	7.3	4.6	5.0	6.1	6.1	5.1
7.8	8.1	8.3	8.2	6.1	2.4	−2.4	4.0	5.6	5.6	6.3	6.7	3.8			
9.9	9.0	10.5	11.4	7.3	3.3	−0.2	3.4	6.4	7.7	8.2	10.0	3.5	5.4	7.8	7.1
7.9	7.7	9.1	8.8	7.0	3.4	0.1	2.9	4.1	6.0	6.8	5.7	3.7			
9.3	15.5	16.3	16.5	14.6	10.1	−1.7	−1.4	3.0	5.4	9.3	7.1	3.6	5.7	6.6	7.2
11.3	7.2	11.5	8.8	6.0	3.7	2.8	3.8	5.4	7.0	7.4	7.1	4.1			
14.3	15.6	17.9	19.2	15.7	13.5	15.5	15.4	15.6	19.5	20.6	20.0	15.2	16.7	15.6	15.1
10.3	8.3	8.9	8.4	3.9	−1.6	−11.6	−1.0	4.3	6.8	9.6	7.9	5.0			
18.8	16.8	19.0	17.2	16.1	4.2	−19.3	−3.3	8.2	8.2	15.0	12.9	8.7	10.9	10.6	9.0
8.9	7.0	8.2	9.1	4.6	−1.6	−12.2	−0.9	3.8	6.6	7.7	7.7	3.4			
11.3	11.2	12.1	12.8	9.5	4.5	−8.8	2.7	4.8	8.1	10.2	9.0	4.2	8.4	9.7	9.2
2.5	2.6	2.8	2.2	0.5	−1.1	−2.7	0.4	1.4	1.6	2.1	1.8	1.1			
6.6	7.0	6.7	5.6	3.9	3.5	1.7	3.1	4.6	4.4	4.9	4.3	3.8	4.6	5.4	4.6

† These figures are computed from *Statistics of Income*, Bureau of Internal Revenue. They include only those categories given in the table and corresponding to the categories of representative corporations.

‡ These figures are based upon analyses of reports of leading corporations. See Table II.

§ When this article went to press, only a "sample" of the representative corporations had made their earnings figures available through 1940 (See Table II). It was nevertheless considered advisable to include ratios for this sample. As these ratios are not strictly comparable with those for the larger number of companies included in 1939 and earlier years, ratios for the same companies as in the 1940 sample were calculated for 1939.

lished or prospective earning power as it is of funds actually at work in the business. In view of the devices of modern accounting and the confusion of legal with economic principles in write-ups, write-downs, surplus items, par and stated values, there is a degree of arbitrariness in statements of capital and in changes therein which does not appear in most figures of gross income, despite limitations in the accuracy of the latter.[1] It is interesting to observe, however, that aggregate capital invested in corporations apparently not only gravitates toward their annual gross income but tends to vary with it, so that percentage which net bears to gross is a very rough indication not only of earning power on capital employed, but also of changes therein.[2]

[1] See this JOURNAL, vol. 29 (March 1934), p. 43, where it is pointed out that gross income as reported by many corporations is made up partly of net items.

[2] See footnote 2, page 483, of this JOURNAL for September, 1936. Thus in the March, 1941, National

The principal source of figures on American corporate income is of course the annual volume on Statistics of Income published by the United States Bureau of Internal Revenue. While these statistics are by far the most complete and accurate available, they are nevertheless two to three years late in publication and throw little if any light upon current conditions. Therefore, in addition to using the federal Statistics of Income it has been necessary to develop series of comparable corporate statistics based upon analyses of the returns of individual corporations.

The number of individual representative corporations whose published reports may be utilized for this purpose is limited by reason of the fact that the great majority of American corporations have not been in the habit of publishing figures of gross income. However, it has been possible to pick out a substantial number of leading and representative corporations which do give the necessary data in their current reports, and to group these corporations into the same categories as those which are presented in the federal figures. In this way it is possible to compare the fluctuations in ratios of net profit to gross income in the two series. The results of this study are spread out in Table I. The average number of representative companies in each group, and the average percentage which their gross income bears to the gross income for all corporations in each corresponding category, as set forth in the Statistics of Income, are shown in Table II.[3]

The data in Table I are presented in graphic form in the following charts. In all the charts there will be noted a substantial degree of conformity in the movements of the ratios of both series in the period from 1918 to 1938, the latest year for which complete federal statistics have been issued. In certain of these groups the conformity is so close that

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City Bank Letter a table is given showing profits of leading manufacturing corporations for 1939 and 1940, "after depreciation, interest, taxes and other charges and reserves" and the percentage return on "net worth" for January 1 of each year. The 1939 figure for "total manufacturing" is 8.4 per cent, while the net to gross for representative corporations in "total manufacturing" given in Table I is 8 per cent for the same year. The closeness of these figures is of course partly coincidental. The "per cent return" given in the National City Bank Letter steps up to 10.5 per cent in 1940, while the net to gross percentage falls slightly, "net worth" not having risen in the interval as fast as gross earnings.

[3] Obviously, the term "representative" applies less to certain groups than to others. In "stone, clay and glass," for instance, there are but three companies in the "representative" category from 1918 to 1938 and consequently the correspondence of their ratio movements to those of the inclusive government group is less satisfactory.

In utilizing the categories of corporations given in Statistics of Income, the author has discarded the following: "agriculture and related industries" (as corporate activity is not typical of agriculture); "finance" (because of wide diversity of non-comparable activities, such as banking, insurance, real estate, stock-broking, and holding company, included therein); "transportation and other public utilities;" "construction;" "forest products;" and "service-professional, amusements, hotels, etc." His figure for "all corporations"—both for representative companies and corporate activity as a whole, as reflected in Statistics of Income—is made up, therefore, of all the categories except those omitted as above mentioned.

TABLE II

AVERAGE NUMBER OF CORPORATIONS FOR WHICH INDIVIDUAL RETURNS WERE ANALYZED AND AVERAGE GROSS INCOME AS A PERCENTAGE OF THE GROSS INCOME OF ALL CORPORATIONS IN THE GROUP REPRESENTED

Industry group	1918–38 Average number	1918–38 Average percentage gross income to gross for all corporations of group	1939 Number representative corporations	1940 Number corporations in sample
Total	187	11.2	185	103
Mining and petroleum	40	46.1	31	13
Total manufacturing	119	12.5	122	78
Food products, beverages and tobacco	26	8.2	27	18
Textiles and their products	13	2.7	13	9
Leather and its manufactures	5	14.6	6	4
Rubber products	8	60.8	7	7
Paper, pulp and products	6	3.4	9	6
Printing, publishing and allied industries	5	3.7	9	3
Chemicals and allied products	10	2.1	9	6
Stone, clay and glass products	3	4.2	4	4
Metals and their products	43	25.2	38	21
Trade	28	5.9	32	12

the ratios of net profit to gross income for all corporations may be forecast with a reasonable degree of assurance by bringing up to date the ratios for individual representative corporations in the same categories.

A word of caution should be inserted here. Any showing of the percentages of corporate gross income which trickle through into net gives us no direct cue to the national distribution of income. Thus there is no discrepancy between the Department of Commerce figures of national income distributed[4] and the series here given, despite the fact that the former show some 12.7 per cent going to capital in the form of interest and dividends in 1938, while the latter indicate that in the same year only 2.2 per cent of gross was converted into net. For here we are con-

[4] In the ten-year period from 1929 to 1938 an annual average of 15.6 per cent of the total national "income paid out" went to capital as dividends and interest. The average annual percentage of net profit on all capital employed to gross income for the same period, for the categories of corporations here dealt with, was 2.33 per cent, after deduction of minus quantities in 1931 and 1932. For the representative companies in the same groups, the annual average was 5.99 per cent.

The percentages are of course not comparable:—(1) National income paid out in many years is greater than national income produced (1930–35 and 1938), and in the period in question (1929–38) nearly 25 billions more were paid out than produced by the Nation's enterprise. This is a reflection of the huge governmental deficits, and the impairment of corporate assets in the years of deepest depression; (2) Corporate gross income is of course entirely different from the net figures of national income produced or distributed; (3) Net profits on total capital employed usually exceed interest and dividends; and (4) The corporate groups analyzed are not inclusive of all corporations (footnote 3), much less of all American enterprise.

cerned with the experience and prospects of "going business" units rather than with the distributive shares of the different factors of production in the Nation's aggregate income.

The payments made by any business for its raw materials, plant and equipment, and other outlays help to make up the gross incomes of other businesses, from which stem earnings on capital employed. Consequently any ratios of net to gross which are built up by aggregating the experiences of many different enterprises must necessarily be less than capital's share of the national income ("produced" or "distributed"), business outlays and receipts in such compilations being gross rather than net items. In other words, it is the nervous system of acquisitive business—profit margins, past, present and prospective—which make up our subject matter. The significance of such margins to the economy as a whole lies in the effects upon employment of labor and general business activity exerted by profits and the fluctuations attributable to changing prospects for such profits.

It should also be borne in mind that these percentages of net to gross built up from aggregate figures of the corporations in each group, include deficits incurred by many companies. Thus in 1938 returns filed by nearly 500,000 active corporations revealed that almost two-thirds of them incurred deficits. What we have here, therefore, is an over-all performance of certain corporate groups as reported to the Bureau of Internal Revenue. The representative corporations, being generally among the leaders in each category, make a better showing.

The following observations now suggest themselves from an examination of the charts and tables:

(1) Corporations as a whole showed a surprising degree of regularity (Chart I) in the proportions of their gross income available as net earnings on total capital employed, including borrowed capital, in the years 1922–29, during which period such ratio of gross available for net profit kept within $4\frac{1}{2}$ to $5\frac{3}{4}$ per cent, and averaged about 5 per cent. It is significant that in 1928 and 1929 this percentage was only a fraction of one per cent higher than in 1922, and was almost the same as in 1923, 1925, and 1926, a slight drop being registered in 1924 and 1927.

The representative series for all corporations has shown the same broad variations from year to year, but these companies—being in general the larger and more successful units[5]—register a higher percentage

[5] William L. Crum in his *Corporate Size and Earning Power* (Harvard University Press, 1939) defines profit as the amount available for equity earnings after taxes. This differs from "net profit" as here used by excluding interest paid for use of borrowed capital. It is of interest to note Professor Crum's conclusion that on the average large corporations are more profitable than small ones. However, this tendency for rate of earnings on shares to advance with size is shown to be true only when corporations reporting deficits are included with those operating in the black, and executive compensation is taken as cost rather than profit-share. These assumptions hold good in the present article.

of gross available as net earnings, with a gradual upward trend discernible between 1922 and 1929, interrupted in 1924 and 1927. The percentage was 8.4 in 1922, 10.5 in 1928, and a little over 11 in 1929. While an increase in the percentage is shown from 1927 to 1929, it is by no means as great as might have been expected, in view of the mounting gross earnings in the latter years of the "New Era" prosperity.

Both series dropped sharply from 1929 to 1932 during which years, for the first time in the entire post-war period, the Nation's corporations in these categories were earning less than nothing. Corporations in the representative series registered a marked upturn from 1932 to 1936–37 in their ability to convert gross into net, while federal statistics show the same trend. These two years brought corporate earning efficiency, measured in percentage of net to gross, to the general levels of 1924—though at no time since 1929 have earnings ratios recovered the levels and the stability of the 1922–29 period. When the inclusive data for 1939 are available a year hence, it will probably be shown that all corporations move with the representative ones in registering a rise in 1939 to about the percentages of 1935, after the slight decline in 1937 and the larger one in 1938.

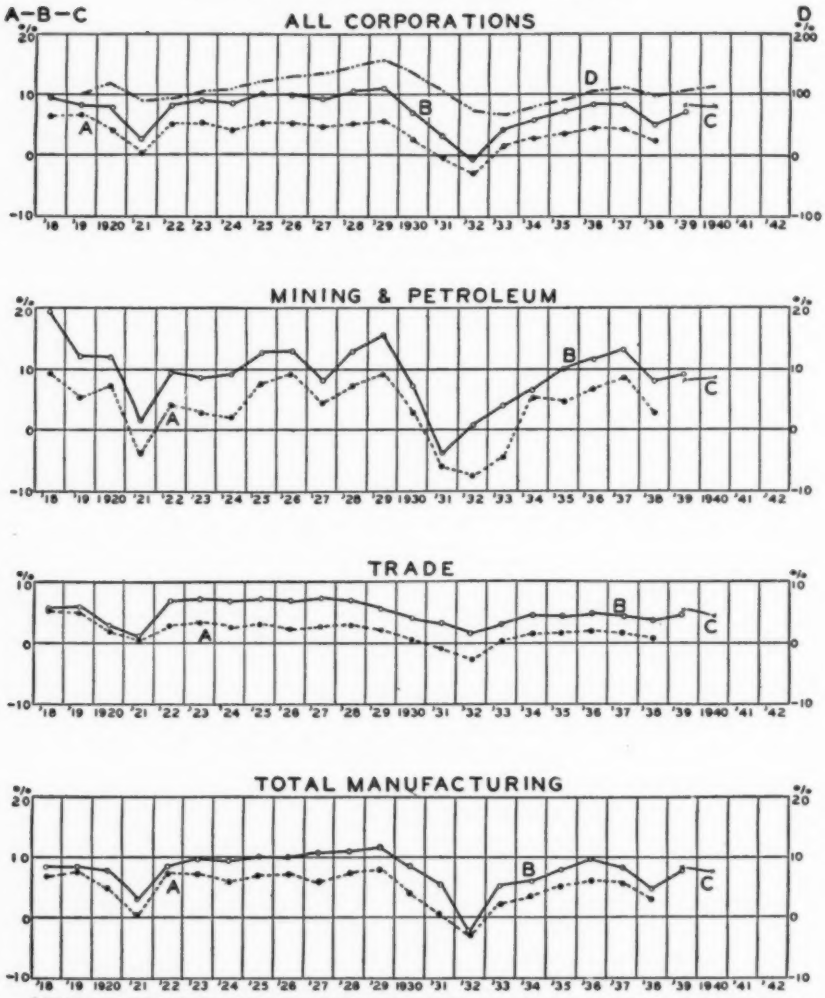
When this went to press the gross and net earnings of a number of representative corporations were available for 1940 (see Tables I and II). From this sample we gain a definite impression that ability to convert gross into net fell somewhat last year, the first full year of the second World War. The similarity of trend for the two series during the twenty-one years 1918–38 in which performance of the representative corporations may be compared with that of all corporations in the categories cited, gives us reason to expect that the federal figures for 1940 will show a similar slight impairment of earning power ratios.

(2) A chief reason, of course, is the heavy incidence of rising corporate taxation. The year 1940 witnessed increases in the basic federal corporate income tax rate from 18 to 24 per cent, and the imposition of an excess profits tax. The prospects of even heavier imposts and the uncertainties of war and of war-time controls make any restoration of the comparative earnings stability of the "twenties" improbable for some time to come.

(3) The dependence of corporate earning capacity upon volume of business is graphically depicted in the charts. Not only does gross income increase in years of prosperity but there is also a tendency, often marked, for the percentage of this gross income coming through into net profit to rise. The opposite is true in the "years of the locust." The accentuated effect upon common stockholders of these wide swings in over-all earning capacity hardly requires comment these days.

CHART I

RATIOS OF NET PROFIT TO GROSS INCOME



A. Ratio of net profit (amount available for interest and dividends after deducting all taxes) to gross income for all corporations in all categories represented — Statistics of Income.

B. Ratio of net profit to gross income for representative corporations in all categories represented — Reports separately analyzed.

C. Ratio of net profit to gross income for smaller sample of representative corporations whose earnings were available (through 1940) when above data went to press. See Table II.

D. Movement of bank debits for cities outside New York (index 1919 = 100.)

This rough relationship between ratios of net profit to gross income and aggregate volume of business expressed in dollar amounts is visualized in the broadly similar movements of bank debits for cities outside New York (line D at the top of Chart I) and the earnings ratios for all corporations and for representative corporations. Variations of bank debits from a 1919 base are here taken as an approximate gauge of the trend of gross corporate receipts.[6] In every year since 1920 upward and downward movements of these bank debit and profit ratios series have synchronized except in 1924, 1926–27, 1937 and 1940, when the former moved up and the latter down, and in 1933, when the reverse was true.

(4) The much greater severity of the second post-war depression than of the first is graphically shown in substantial recovery of earlier earning power in the one year from 1921 to 1922 as contrasted with the recuperative period of four years from 1932 to 1936, a recuperation not completed when the setback of 1937–38 intervened.

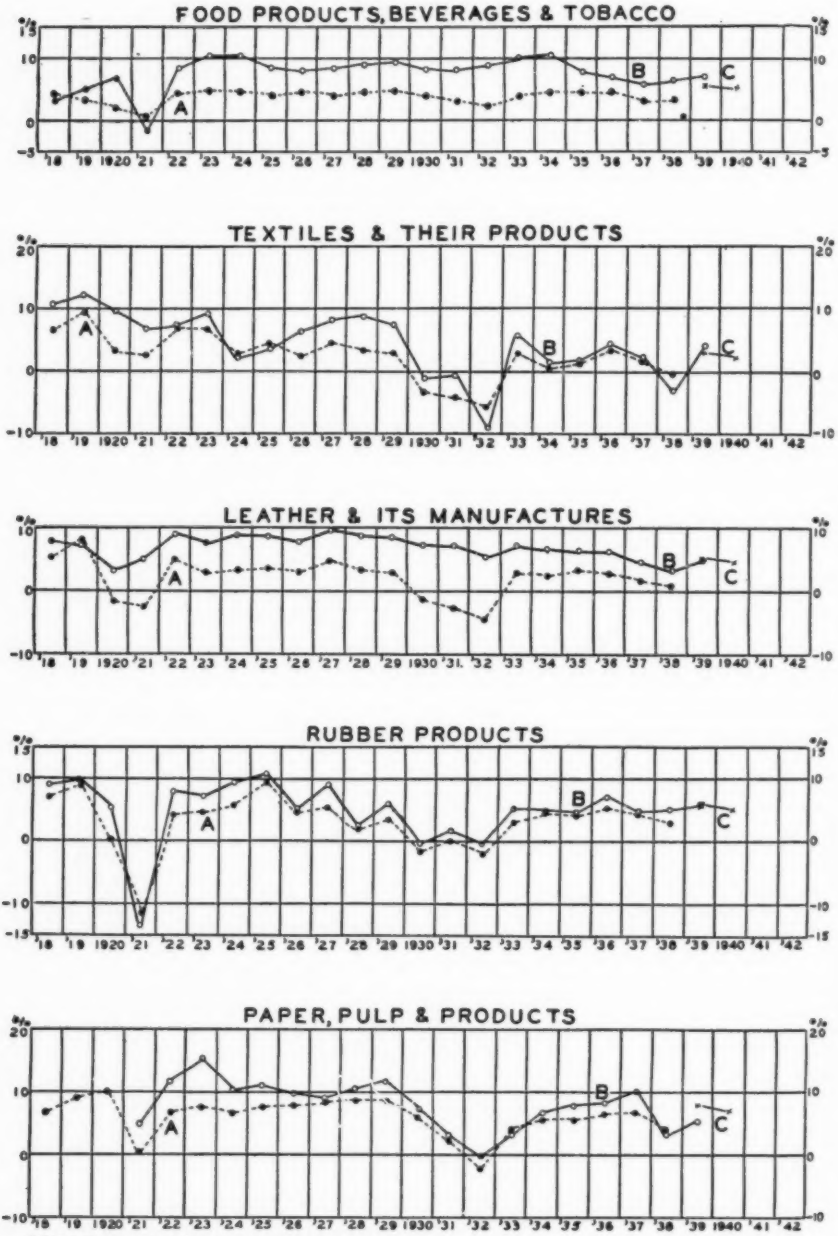
(5) Ratios of net profit to gross income from 1922 to 1929 showed a high degree of consistency in Total Manufacturing (Chart I) and here as well, the two lines move practically simultaneously, exceptions being in 1923 and 1927. For all corporations the ratio was less than 1 per cent higher in 1929 than in 1922, the average for this period being about 7 per cent, with decreases in 1924 and 1927. Again it may be remarked that the increase in ratio from 1927 to 1929 is by no means as great as might have been expected in the boom preceding the 1930–35 depression, and serves to point out the lesser degree of efficiency than is commonly supposed to have characterized industry in those years. The plunge from 1929 became even more precipitate from 1931 to 1932 (for representative corporations); and in the latter year the two series were close together in the No Man's Land of algebraic negatives. The recovery in 1933 was sharp for both series and continued through 1936, though by 1938 the net to gross had declined in representative companies to near the 1931 and 1933 levels, and in all companies to the vicinity of the 1934 level.

(6) Among the other groups given in the table the greatest degree of stability from year to year is to be found in Trade, and in Food Products, Beverages and Tobacco (Charts I and II). In the latter the percentage for all companies was practically the same in 1938 as in 1919, and a horizontal line can be drawn through most of the points from 1922 to 1933; while for representative corporations in the same group the 1939 percentage was not far from that of 1920.

[6] In the author's article on "Corporate Earnings" in this Journal, March, 1934 (p. 47) it is pointed out that bank debits for cities outside New York have a close relationship to corporate gross earnings, the latter approximating one-half of the former over a considerable period of years.

CHART II

RATIOS OF NET PROFIT TO GROSS INCOME


FOOD PRODUCTS, BEVERAGES & TOBACCO
TEXTILES & THEIR PRODUCTS
LEATHER & ITS MANUFACTURES
RUBBER PRODUCTS
PAPER, PULP & PRODUCTS
%
A
B
C
'18 '19 1920 '21 '22 '23 '24 '25 '26 '27 '28 '29 1930 '31 '32 '33 '34 '35 '36 '37 '38 '39 1940 '41 '42

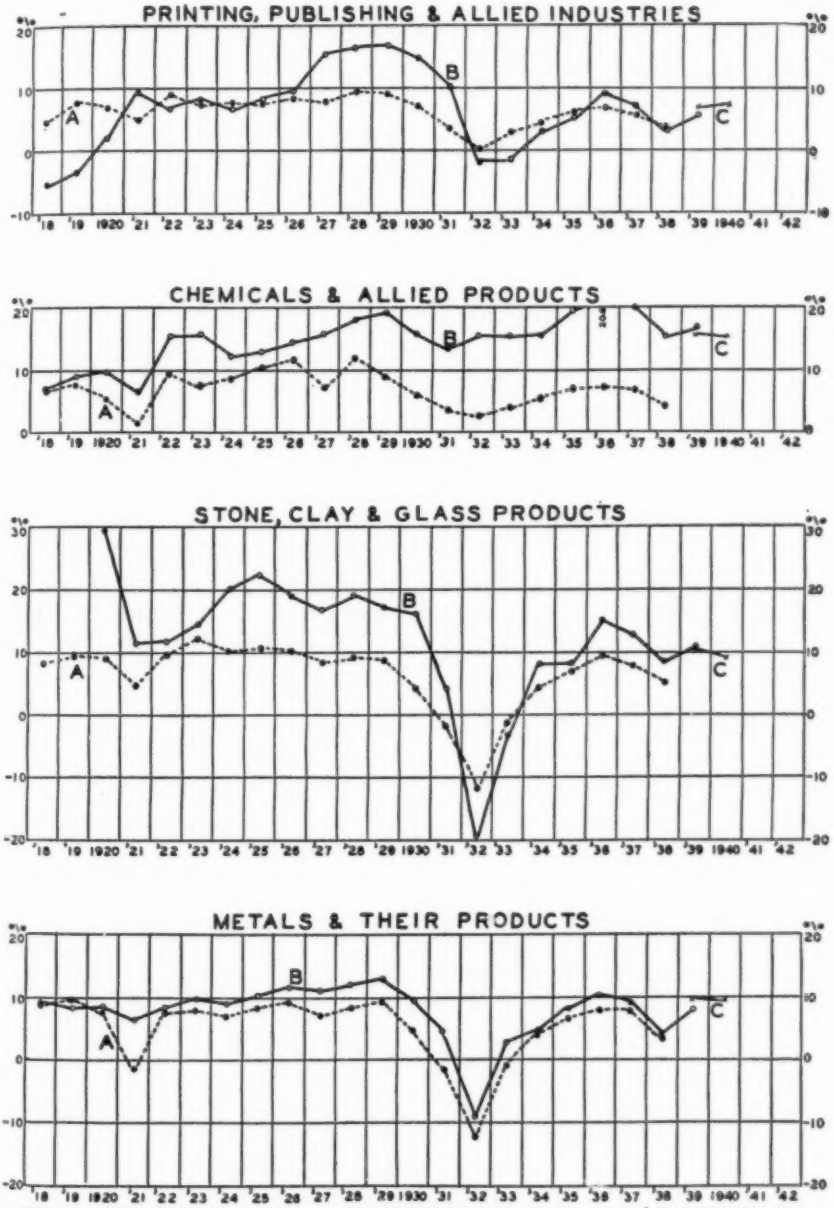
A-RATIO OF NET PROFIT (AMOUNT AVAILABLE FOR INTEREST AND DIVIDENDS AFTER DEDUCTING ALL TAXES) TO GROSS INCOME FOR ALL CORPORATIONS IN ALL CATEGORIES REPRESENTED — STATISTICS OF INCOME.

B-RATIO OF NET PROFIT TO GROSS INCOME FOR REPRESENTATIVE CORPORATIONS—REPORTS SEPARATELY ANALYZED.

C-RATIO OF NET PROFIT TO GROSS INCOME FOR SMALLER SAMPLE OF REPRESENTATIVE CORPORATIONS WHOSE EARNINGS WERE AVAILABLE (THROUGH 1940) WHEN ABOVE DATA WENT TO PRESS. SEE TABLE II.

CHART III

RATIOS OF NET PROFIT TO GROSS INCOME


PRINTING, PUBLISHING & ALLIED INDUSTRIES
CHEMICALS & ALLIED PRODUCTS
STONE, CLAY & GLASS PRODUCTS
METALS & THEIR PRODUCTS
%
A
B
C
'18 '19 1920 '21 '22 '23 '24 '25 '26 '27 '28 '29 1930 '31 '32 '33 '34 '35 '36 '37 '38 '39 1940 '41 '42

A RATIO OF NET PROFIT (AMOUNT AVAILABLE FOR INTEREST AND DIVIDENDS AFTER DEDUCTING ALL TAXES) TO GROSS INCOME FOR ALL CORPORATIONS IN ALL CATEGORIES REPRESENTED — STATISTICS OF INCOME.

B RATIO OF NET PROFIT TO GROSS INCOME FOR REPRESENTATIVE CORPORATIONS — REPORTS SEPARATELY ANALYZED.

C RATIO OF NET PROFIT TO GROSS INCOME FOR SMALLER SAMPLE OF REPRESENTATIVE CORPORATIONS WHOSE EARNINGS WERE AVAILABLE (THROUGH 1940) WHEN ABOVE DATA WENT TO PRESS. SEE TABLE III.

Corporations engaged in Trade suffered an elimination of their earning power in 1931 and 1932, but by 1933 had reached the black again. Representative companies in this group, however, showed earnings through the depression's depths, and seem to have reached by 1934 a fairly stable ratio of earning power lower than obtained from 1922 to 1929.

Companies in the Food Products, Beverages and Tobacco group were comparatively little affected by the depression in their ratios of net profit to gross income. The charts show why shares in companies of this category are sometimes known as "resistance stocks."

(7) The other groups show wider variations from year to year, though the two series move along pretty well together. Until the world political situation is clarified and something like stable conditions return, it will be impossible to establish any long-term upward or downward trends, but there is nothing which gives promise of a restoration of the earning capacity of the decade of the twenties.

(8) Apart from whatever light may be thrown by research of this kind upon business movements in general, it is also of practical use in studying the performance of individual companies against the background of group experience. Any such application of this method, however, easily leads to unwarranted conclusions unless the characteristics and peculiarities of each company are taken into consideration and the groupings are essentially homogeneous in character. The varying methods of charging depreciation, and the exigencies of inventory profit and loss will also call for exercise of critical judgment.

SOURCES AND USES OF CORPORATION FUNDS*

By Arthur B. Hersey[1]
Board of Governors of the Federal Reserve System

This paper outlines a method of analyzing a series of year-end corporation balance sheets in such a way that changes in all asset and liability items are viewed in relationship to each other. Such an analysis is particularly helpful in illuminating the effective causes of changes in cash holdings and indebtedness of the corporations studied.

Increases in assets may be said to involve *uses of funds* by a corporation; increases in surplus or liabilities reflect and identify *sources of funds*. Thus, capital expenditures and the accumulation of inventories may be said to be uses of funds; among sources of funds are current earnings, short-term borrowing, security issues, and also drafts on cash, for the decrease of an asset may be regarded as a source of funds for expenditure.

The use of the term "funds" does not imply an attempt to reduce corporation accounts to a "cash-flow" basis. As used here, "funds" is merely a logical construct: "that which is debited and credited." Starting with the balance sheets for terminal dates and the income statements that constitute the final product of the accountants' work, the analyst works back to a balancing set of net credits and net debits for the year, each item of which is to have some economic significance. In this process he eliminates some inter-account ("non-cash") credits and debits made by the accountants. He may combine accounts, or shift them—with signs reversed—from one side of the balance to the other. It might be possible to trace the component parts of an adjusted "net source of funds" item back to their origins as credits paired with debits to cash, with debits to accounts receivable, or with debits to other accounts,[2] but in the balanced statement for a given period these distinctions are obliterated. A net "source of funds" in any one category merely implies that all other categories show a combined net "use of funds," in the sense indicated, of equal magnitude.

The adjustments made on the year-to-year changes in balance sheet

* A paper presented at the 102nd Annual Meeting of the American Statistical Association, Chicago, December 28, 1940.

[1] The writer has had the stimulating assistance of George P. Hitchings and Edward Boorstein.

[2] For example, a source of funds (not subject to adjustment) from stock issuance in a merger might have originated with a debit to fixed assets for property acquired. Again, a source of funds from inventory liquidation may be traced back to the excess of debits to cost of goods sold (for inventory passing into sales) over credits to cash, accounts payable, depreciation reserve, etc. (for materials, labor, and other costs charged to inventory). Debits to cost of goods sold are strictly non-cash entries, determined perhaps by past charges to inventory, but not by any current cash or receivables transactions with outside persons.

items are determined solely by considerations of usefulness for analysis. For example, a decline in capital stock that resulted from restatement of par value is to be adjusted, for obvious reasons; the apparent negative source of funds in this account is to be cancelled off against the apparent source of funds in surplus. Similarly, all declines in net fixed property account that resulted from debits to surplus or to profit and loss (writedowns and depreciation charges) are to be adjusted, so that the computed net use of funds for fixed assets ("capital expenditures") will be on a gross basis.[3] This procedure rests on a judgment that gross outlays for plant and equipment are a better datum for economic analysis than unadjusted changes in net property account. So-called "consumption" of fixed property, as measured by the accountants' straight-line original-cost depreciation, is not closely related to real losses of productive power through wear and tear and obsolescence. These are but two examples of numerous judgments that must be made in developing any set of source and use of funds items.

Charts I–VI relate to combined sources and uses of funds of 58 large companies in six industries: steel, petroleum, automobiles, machinery, rubber, and tobacco. This group of companies constitutes about one-fifth of all manufacturing and mining,[4] but is heavily weighted with producers' goods manufacturers. The financial statements used are those published in *Moody's Manuals*, which in many cases give a great part of the information available in statements filed with the SEC.[5] The computations made are subject to continuing revision. The period covered is the ten years 1930–1939.[6]

The reader should be cautioned that combined figures for a group of companies may not always reflect the actual behavior of individual companies. For example, in a sample of two companies one might have drawn down cash to increase inventories while another reduced inventories and retired debt; the inventory changes might wash out in combination, leaving a reduction in cash against a retirement of debt in the sample as a whole though neither company had drawn down cash to pay debts. Conclusions must be checked against components of the sample.

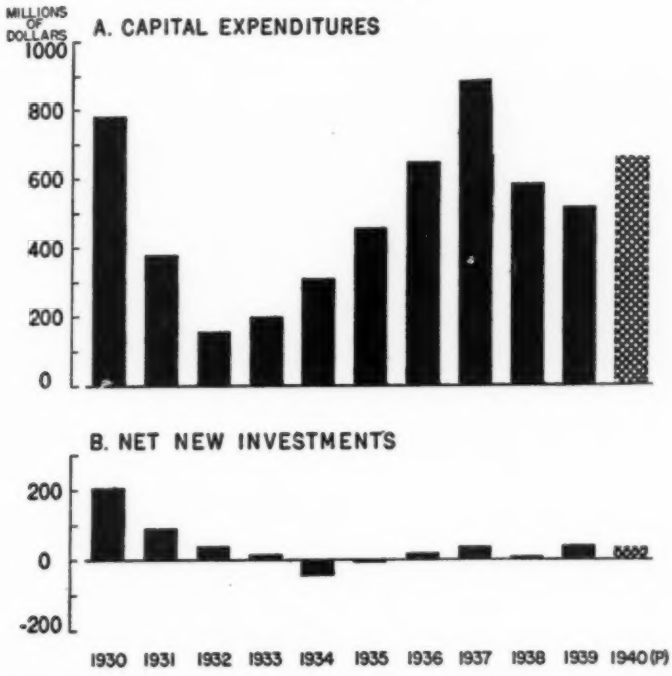
[3] Gross with respect to depreciation, etc., though net with respect to sums realized upon scrappage or disposal.

[4] At the end of 1933 total assets of the 58 corporations were $11,267,000,000, their inventories $1,796,000,000 and their cash and marketable securities $1,245,000,000. At the end of 1937 the corresponding figures were respectively $12,413,000,000, $2,803,000,000 and $917,000,000.

[5] Even with this information, it has not always been possible to make all adjustments theoretically called for. Some adjustments have been estimated. Few adjustments of less than $100,000 have been made, even where the data permitted.

[6] Preliminary figures for 1940 are also shown in the charts.

CHART I
USES OF FUNDS



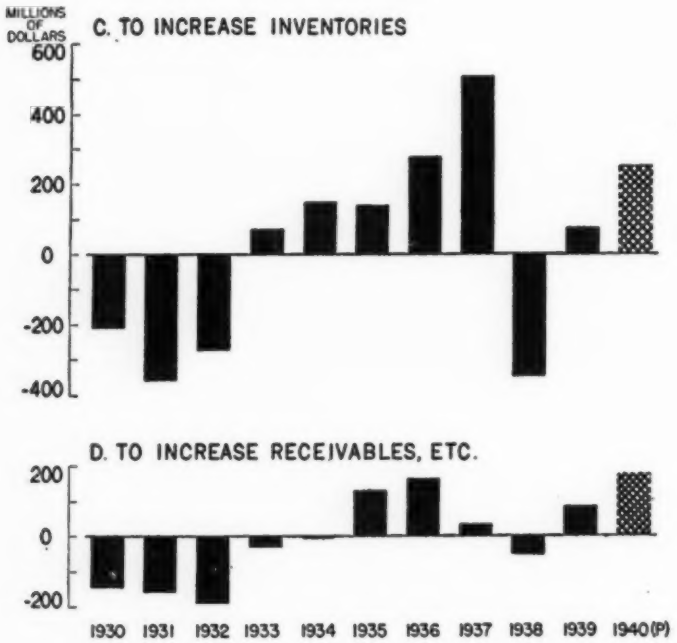
(a) The largest category of use of funds, on an annual basis, is usually *"capital expenditures"* (Chart I). This series represents expenditures for land, plant and equipment, less sums realized upon scrappage or disposal.[7] The figures show a characteristic business cycle pattern similar to that of net earnings (the total bars in Chart III), though with some tendency to lag in early phases of recession or recovery.

(b) *"Net new investments"* refers mainly to net new investments in securities of affiliates, whether carried on the balance sheet as investments or distributed among other accounts through consolidation.[8] The economic significance of this category is not clear-cut; in some respects it may be assimilated to capital expenditures, in other respects it is a negative of long-term finance.

[7] Computed by taking changes in net property account and adjusting (1) upwards for depreciation, depletion and amortisation charges credited to gross property or depreciation reserves (adding also, for some companies, charges for actual outlays—as for oil-field development—which other companies capitalize and amortize), (2) upwards for writedowns or losses charged to surplus, and (3) downwards or upwards for changes resulting from mergers and consolidations and from reclassifications of assets.

[8] Computed as the change in accounts representing non-current investments, adjusted upwards for amounts paid (in cash or stock) in acquisition of new subsidiaries consolidated, and for writedowns.

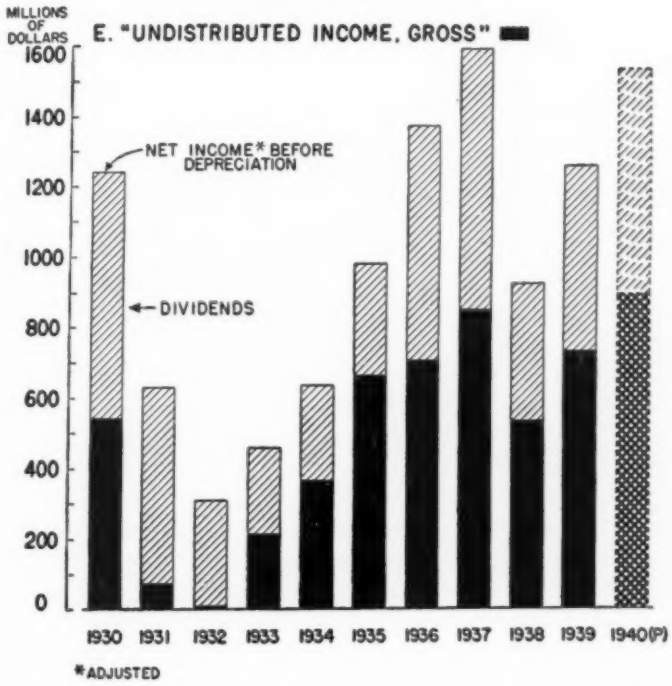
CHART II
USES OF FUNDS



(c) Funds used "*to increase inventories*" (Chart II) are often of major importance in short periods. Even on an annual basis the variations are sometimes much larger than those of capital expenditures. Unlike capital expenditures, these figures are negative in some years. The figures correspond to yearly changes in book value of inventory as computed by the companies' accountants.[9] Since usual methods of inventory accounting allow the whole inventory to increase in value when costs rise, and *vice versa*, this series does not necessarily represent changes in physical inventories. The figures as charted show a great volume of funds realized from inventory liquidation in 1930–1932 and in 1938. Especially in the earlier period, this represented only in part the liquidation of physical inventories. Other methods of accounting, by imputing less decline in value to the inventories on hand, might have shown part of these funds as coming from current net earnings.

[9] Minor adjustments are made for year-end writedowns where the data allow. In cases where the writedown is presumed to have affected net income and inventory change in the following year, adjustments are made on those quantities as well. The results correspond to what would be found if the companies followed their usual inventory accounting procedures consistently but without making writedowns. Adjustments are occasionally made in connection with consolidations.

CHART III
SOURCE OF FUNDS



(d) A fourth use of funds, "*to increase receivables, etc.*" (Chart II), represents the year's change in book value of receivables and miscellaneous current assets.[10] From 1934 on, the cyclical movements in this series—so far as they are observable from yearly figures—seem to lead the movements of inventory changes by some fraction of a year.

(e) Turning to the flows of funds classified as sources, the largest on the average is "*undistributed income, gross*" (Chart III, solid bars). This is a single summary figure for current earnings less costs, expenses, and cash dividends.[11] It differs in one important respect from the ordinary accounting figure of net income less cash dividends paid.[12] Because we disregarded capital consumption in taking as a use of funds

[10] No adjustment is made for bad debt writedowns. All additions to receivables are non-cash transactions; a writedown merely indicates, *post facto*, that such additions had previously been excessive. (See footnote 16.)

[11] In a detailed analysis the payment of dividends might be treated as a separate use of funds. Total sales might even be given as a source item; costs and expenses deducted in arriving at net income would then be given as one or more use items.

[12] Other minor differences result from adjustments for writedowns, capital gains or losses, etc., in connection with counteradjustments on certain asset and liability accounts.

not the expansion of net depreciated property but the actual expenditures on plant and equipment, we now disregard charges against income for capital consumption and take net income before the accountants' deduction of depreciation, as a source of funds.

Since dividend payments are more stable than net income and changes in dividends lag behind changes in income, "undistributed income, gross" generally alters more rapidly during the early phases of recession or recovery than does net income (before depreciation). The undistributed profits tax imposed in 1936 and virtually removed in 1938 influenced the timing of dividend payments and largely explains the very small gain in undistributed income in 1936 as well as the moderate size of the drop in 1938, a recession year in which dividends were sharply reduced contrary to usual expectations.

(f) Another source item, funds obtained "*through increase in accounts payable and accrued liabilities, etc.*" (Chart IV), represents the year's increase in such current liability accounts as trade payables, accrued or reserved-for taxes, interest and payrolls, and dividends payable. The yearly figures have a cyclical pattern of change, from 1934 on, very much like that of "funds used to increase receivables" (Chart II).

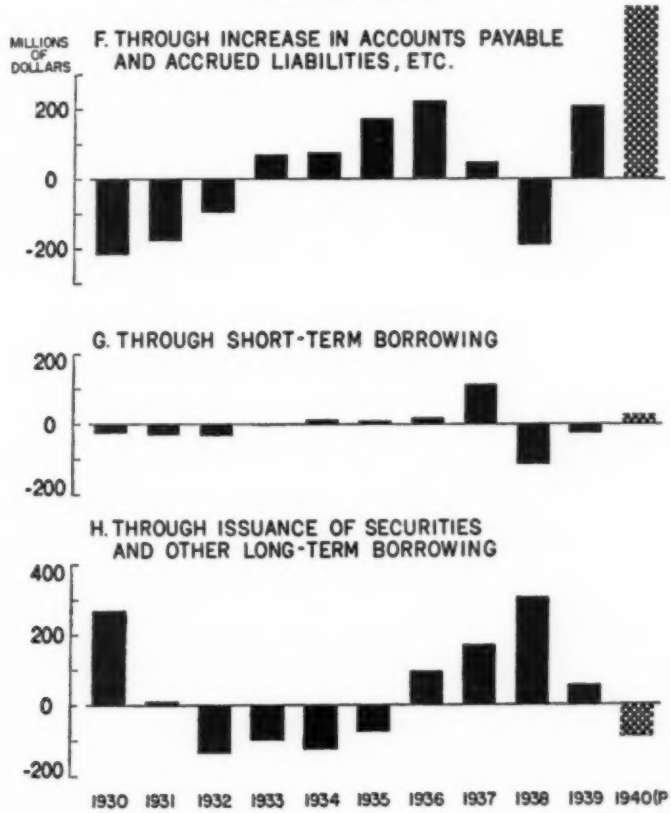
(g) Three of the source-of-funds categories may be called "financial sources." Two of these, shown in Chart IV, may also be called "external sources." The first of these is "funds obtained through short-term borrowing."[13] Except in 1937 and 1938, these 58 corporations apparently accounted for a rather small part of the important changes during this ten-year period in banks' short-term commercial loans and open-market commercial paper.

(h) The second "external" source of funds, "*through issuance of securities and other long-term borrowing*" (Chart IV), includes common and preferred stocks, bonds, and term loans.[14] This series shows a rather different cyclical pattern than the other series in Charts I–IV. First, unlike those series that relate to current assets and liabilities, it has a fairly smooth broad sweep. Second, it tends to lag behind all the other series. However, the lag at 1937–1938 is perhaps exaggerated by the chart, for the 1938 figure includes a single $100,000,000 bond issue of

[13] Computed by taking yearly changes in notes payable shown as current liabilities, and adjusting to exclude long-term debt items placed among current liabilities as they approach maturity.

[14] Issues in exchange for assets or as bonuses are included but stock dividends are excluded. All redemptions and repurchases are taken as deductions (whether or not securities repurchased were retired) by using such asset accounts as treasury stock in the computation. The figures are put on a value-received rather than par value basis, so far as the data permit; i.e., adjustments are made against surplus and unamortized debt discount to reflect premiums, discounts and expense of issuance, and restatement of common stock value. If cash has been earmarked for security redemption, redemption is regarded as taking place at that time.

CHART IV
SOURCES OF FUNDS

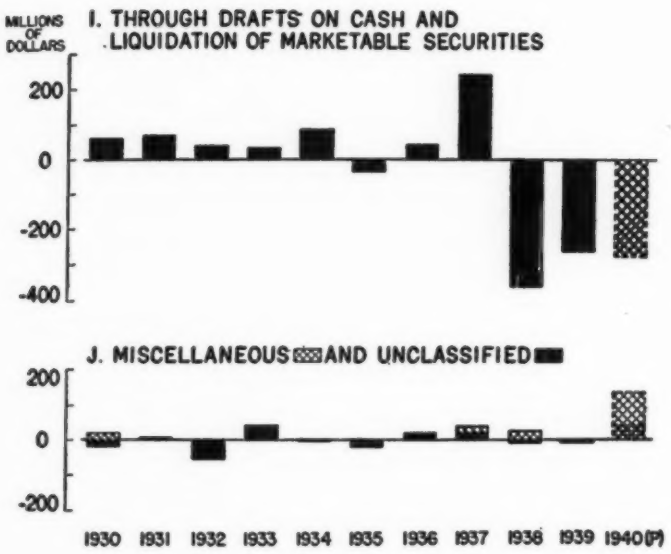


U. S. Steel which under slightly different circumstances might have been offered in 1937. It is noteworthy that sums used to retire indebtedness and preferred stocks over the years 1932 to 1935 were about two-thirds as great as the net amount obtained from security issuance and other long-term borrowing in the following four years.

(i) The third "financial" source of funds is *"through drafts on cash and liquidation of marketable securities"* (Chart V).[15] A positive figure here means a decline in an asset. The data for individual companies show more scatter in the size and direction of yearly changes in cash and equivalent than in practically any of the other source or use of funds categories, but a definite pattern emerges when a sizable sample is built up. The 58 companies combined reduced their cash and equiva-

[15] Cash and marketable securities have been combined in the chart for simplicity's sake; there has been some tendency since 1934 for these companies to shift from marketable securities to cash.

CHART V
SOURCES OF FUNDS

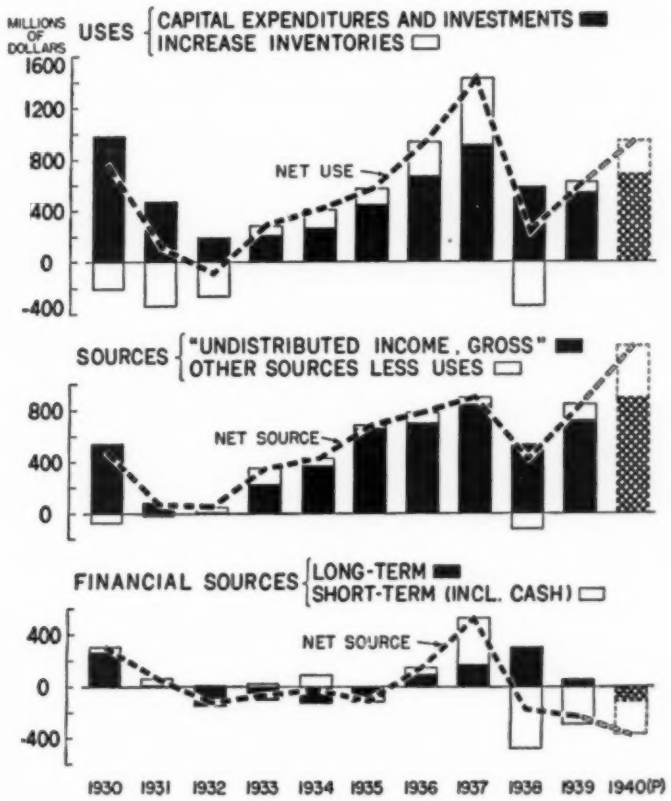


lent in every year but one up to 1937. It is clear that the economic problem of "idle cash" is not a problem of cash in the hands of large manufacturing companies. However, drafts on cash were relatively small until 1937; in no year before 1937 did the net total change in cash and equivalent on hand exceed 7 per cent. Over the whole period from end of 1929 to end of 1939 there was a net increase of about $90,000,000, or 6 per cent.

(j) Finally, there are "*miscellaneous*" and "*unclassified*" sources of funds (Chart V). The "miscellaneous" sources include a few large special receipts such as refunds of taxes paid in earlier years and advance payments on certain long-term contracts. The reasons for an "unclassified" category are (1) lack of sufficient footnote information in the financial statements used, and (2) the desire to keep the other categories as clear-cut as possible and to avoid setting up a number of small miscellaneous categories.[16]

[16] The unclassified class mainly reflects certain changes in contingency reserves and surplus and in miscellaneous non-current assets and liabilities. Increases and decreases in contingency reserves in certain cases might be allocated respectively as additional net income and as upward adjustments on changes in asset accounts written down to reserves. There are objections to this procedure, partly arising from lack of data. For example, it is undesirable to adjust the change in receivables, say, upward in one year unless counteradjustments downward can be made in preceding years when the sales were made which later proved uncollectible; otherwise an unreal upward bias would be given to the cumulated net change in receivables. (A net effect of such upward and downward adjustments on receivables would probably be to reduce the apparent amount of liquidation for 1932 shown in Chart II.)

CHART VI
SUMMARY



The series reviewed raise interesting questions of classification and definition. They are also interesting as sample indexes, even though they may be unrepresentative of larger aggregates. But their chief interest lies in the composite picture they yield, an objective bird's-eye view of the process of corporation financing at work. In Chart VI an attempt is made to summarize this composite picture.

The upper part of the chart shows the net total of funds used each year for capital expenditures, new investments, and inventories. The second part shows the net total of funds obtained from accrued income, from changes in accounts payable less accounts receivable, and from miscellaneous and unclassified sources. This roughly approaches a "cash-basis" total of funds from current operations. The bottom part shows the net total of funds obtained from "financial "sources.

The financial operations of these 58 corporations during the years 1930–1939 seem to exemplify three principles.

First, *that net issuance of securities and other long-term borrowing bears no simple relationship—either as to amount or timing—to capital expenditures and net new investments.* Observe the increase in capital expenditures from 1933 to 1935 and the steady rate of net liquidation of long-term finance in those years, and the rise and fall of capital expenditures from 1936 to 1938 and the steady increase in new long-term financing in those years. In all of these years current earnings provided much of the funds needed for capital expenditures. The need to draw on financial sources developed in proportion not to capital expenditures themselves, but to the excess of capital expenditures and inventory expansion combined over funds retained from earnings. And long-term borrowing was only one of the available financial sources. So far as large manufacturing corporations during this period were concerned, the notion that new capital issues supplied an index to fixed asset expansion had no validity. The term "issues for new capital" should be used to refer to "capital" only on the *liability* side of the balance sheet.

Second, *that short-term financing with notes payable or by drawing down cash or equivalent tends to act as a cushion* to absorb for a while an increase in funds needed for fixed or working asset expansion or renewal which cannot be met from currently retained cash receipts from operations. The short-term financing of these companies in 1936 and 1937 is a striking example; a number of these companies also did more short-term financing with cash and equivalent in 1934 than in adjacent years, 1934 being a year when their requirements met from financial sources were greater than in adjacent years. But after a period of heavy short-term financing, a reaction tends to set in. Observe the liquidation of short-term finance in 1938 and 1939, and also in 1935.

Third, *that long-term financing comes into play only as needs for funds persist or expand beyond the capacity of short-term financing to provide for them, or else as corporations find it desirable and possible to finance at long-term in order to strengthen their short-term position.* But with long-term financing, too, there are incentives to liquidate debts when funds are available for the purpose. Observe the liquidation of long-term finance in 1932–1935.

Conclusions from the sample data for this period do not seem to be accidental; data for subgroups of this sample also show these statistical tendencies at work, of course with due exceptions.[17] How far these generalizations may be applicable to the financing of companies of lesser financial standing than these or of companies in other fields of business remains an open question.

[17] During a period of substantial price or tax increases, corporations may experience a continuous pressure to increase their cash balances. This would require some modification of the "impact-cushioning" view of changes in cash holdings developed in this paper.

THE VALIDITY AND SIGNIFICANCE OF MALE NET REPRODUCTION RATES

By Robert J. Myers, *Social Security Board*

Analyses of reproductivity commonly utilize the female net reproduction rate (or else the "intrinsic rate of increase" determined therefrom). There is calculated the number of daughters that will be born to 100 females who start life together and are subject to specified fertility and mortality rates. Instead of relating daughters to females, there might just as readily be computed the sons that will be born to 100 males.[1] Although at first glance it would seem as though rates for men are without meaning since women actually bear the babies, it should be remembered that where there is a mother, there must also be a father. Of course, one man could be father to several babies in a given year, but on the other hand, one woman could give birth to twins or triplets. This paper will first examine the theoretical aspects of male versus female net reproduction rates and then analyze actual data for the United States.[2]

Digressing a bit, it may be pointed out that the usual definition of the net reproduction rate for women may be, and in practice usually is, modified somewhat in order to facilitate calculation. Instead of using age-specific birth rates based on female births as called for by the definition,[3] rates based on total male and female births may be used. The necessary adjustment is made by multiplying the sum of the products of the age-specific birth rates and female survival rates by the proportion of births that are female.[4] In actual practice such total age-specific birth rates are often available instead of the female age-specific birth rates required by the definition.

In a theoretical stationary population, although the age-specific birth rates for men (paternal frequency by age)[5] differ from those for women, the two net reproduction rates will always be the same. However, because of varying sex proportions at the reproductive ages, actual popu-

[1] This device was developed by Professor E. I. Gumbel (see Kuczynski, Robert R., *Fertility and Reproduction*, p. 36).

[2] Kuczynski on pp. 36–38 of *Fertility and Reproduction* calculates reproduction rates for both sexes for France and makes some analyses of the difference between the two rates. However, as far as the author knows, the theoretical aspects of this subject as well as its application to United States data have never been fully examined.

[3] For an illustration of the theoretical method of calculating net reproduction rates, see Dublin, Louis I., and Lotka, Alfred J., *Length of Life*, p. 245.

[4] This procedure is followed by Kuczynski (see footnote 2). For an analysis of the accuracy of this approximate method see Myers, Robert J., "Population, Birth, and Mortality Trends in the United States," *Transactions of the Actuarial Society of America*, Vol. XLI, May 1940, p. 101.

[5] I.e. ratio of births to fathers of a given age to total number of men of that age.

lations frequently give different values when separate calculations are made. If there is a temporary excess of females at the reproductive ages, age-specific birth rates and the net reproduction rate calculated for women will be relatively low as compared with those computed for men. For example, a calculation covering the experience in France during 1920–23 gave a net reproduction rate of 97.7 for women and 119.4 for men.[6] This large difference is readily explained by the smaller number of men in the reproductive ages as a result of the ravages of the First World War. It is not always possible to say whether in a given case men are over-represented or women under-represented in the population (or *vice versa*). Therefore, it seems that consideration might well be given to the possibility of using the male rate as well as the female for an index of the "intrinsic rate" of population growth.

One cause of differences between the male and female net reproduction rates as calculated for a given population is a lack of balance between the sexes at the reproductive ages. Two ways that this can occur (or appear to occur) are through immigration and through misstatement of age in census reporting. The following discussion will examine these two factors, using as a base a hypothetical stationary population resulting from 100,000 female births each year in the past.

Table I shows the effect of excess female immigration (namely, 10,000 aged 20 in each future year) on the calculated net reproduction rate based upon the assumption that this influx has no effect on the number of births. This is quite possible, since the total male population is not changed, so that the total number of marriages and births might conceivably remain as before. Prior to immigration, it has been assumed that the birth rate set down in column 3 would be in effect so that the number of births would be as in column 4. These rates were so selected as to result in a net reproduction rate of exactly 100.

After 30 years of immigration, the age distribution of the female population is as shown in column 5. The age-specific birth rates at this time are obtained by dividing the births of column 4 by the larger population of column 5 and result in a net reproduction rate of only 91.3. On the other hand, in such a population the net reproduction rate calculated for men would have remained at 100 throughout the entire period rather than decreasing steadily as did the female rate. If the excess female immigration were to cease and the number of births continue constant, the female net reproduction rate would gradually increase until after another 30 years it would again be 100. In this particular instance the male net reproduction rate seems to be the more reliable,

[6] See footnote 2.

TABLE I

EFFECT OF IMMIGRATION ON NET REPRODUCTION RATE OF STATIONARY POPULATION* WITH ASSUMED AGE-SPECIFIC BIRTH RATES†

Age group (1)	Prior to immigration		Number of births‡ (4)	After 30 years of immigration	
	Women (2)	Birth rate† (3)		Women (5)	Birth rate§ (6)
15–19	457,285	52	23,779	457,285	52.0
20–24	451,278	130	58,666	500,902	117.1
25–29	443,786	120	53,254	492,586	108.1
30–34	435,638	80	34,851	483,542	72.1
35–39	426,397	60	25,584	473,285	54.1
40–44	415,333	20	8,307	461,005	18.0
45–49	401,224	3	1,204	445,344	2.7

Net reproduction rate, prior to immigration¶ =100.0
Net reproduction rate, after 30 years of immigration** =91.3

* Based on U. S. White Females 1929–31 Table. It is assumed that there are 10,000 female immigrants each year in future (all at age 20).

† These rates are arbitrarily set down and apply prior to immigration.

‡ It is assumed that the number of births by age of mother are not changed by the female immigration.

§ 1000 times column 4 divided by column 5.

¶ Obtained by cumulative multiplication of columns 2 and 3, the result being then multiplied by .4864 (the proportion of girl births based on a sex ratio at birth of 105.6) and divided by 1,000,000.

** Obtained by cumulative multiplication of columns 2 and 6, the result being then multiplied by .4864 and divided by 1,000,000.

but of course it is recognized that excess male immigration would produce exactly the opposite result.

Similar to the effects of immigration, the ravages of war in depleting the ranks of the young men could have the effect of producing a relatively low female net reproduction rate and, correspondingly, a relatively high male rate. After conditions had had a chance to stabilize, it is quite likely that the two net reproduction rates would again approach more closely.

Table II deals with a stationary female population in which there are assumed to be certain arbitrary biases in the reporting of ages; however, it is hypothesized that there is accurate reporting of the ages of mothers in connection with the births. In accordance with United States population characteristics women over 30 are assumed to understate their ages (10 per cent of those in each quinquennial age group understating by 5 years and 5 per cent understating by 10 years with the other 85 per cent correct), while those under 20 are assumed to overstate (10 per cent overstating by 5 years), with those between 20 and 30 reporting correctly (or with counterbalancing errors). A set of assumed "true" birth rates has been selected to apply to the correct ages of women, namely the same as in Table I. The application of these

TABLE II

EFFECT OF BIAS IN REPORTING OF AGE* ON NET REPRODUCTION RATE OF STATIONARY POPULATION† WITH ASSUMED AGE-SPECIFIC BIRTH RATES‡

Age group (1)	Women in age group according to Life Table (2)	"True" birth rate‡ (3)	Number of births (4)	Women in age group for bias in reporting of age (5)	"Reported" birth rate§ (6)
10–14	460,973	—	—	—	—
15–19	457,285	52	23,779	457,654	52.0
20–24	451,278	130	58,666	518,788	113.1
25–29	443,786	120	53,254	508,670	104.7
30–34	435,638	80	34,851	433,699	80.4
35–39	426,397	60	25,584	424,032	60.3
40–44	415,333	20	8,307	412,292	20.1
45–49	401,224	3	1,204	379,314	3.2
50–54	382,740	—	—	—	—

Net reproduction rate, no bias¶ =100.0
Net reproduction rate, with bias** =93.2

* It is assumed that all bias exists in the female population and that there is none in the data dealing with ages of mothers for the births.

† Based on U. S. White Females 1929–31 Table.

‡ These rates are arbitrarily set down and are assumed for the purpose of this discussion to be theoretically "true" rates such as would be obtained if no bias in age reporting existed.

§ 1000 times column 4 divided by column 5.

¶ Obtained by cumulative multiplication of columns 2 and 3, the result being then multiplied by .4864 (the proportion of girl births based on a sex ratio at birth of 105.6) and divided by 1,000,000.

** Obtained by cumulative multiplication of columns 2 and 6, the result being then multiplied by .4864 and divided by 1,000,000.

rates to the "true" female population results in the births shown in column 4. Column 5 lists the population as it might presumably be reported by a census, while column 6 giving the "reported" birth rates lesults from dividing the total births by total reported women. These ratter age-specific birth rates produce a net reproduction rate of only 93.2 so that the assumed bias in age reporting was responsible for a 7 per cent error.

Another cause of difference between the net reproduction rates for men and women is the immaturity of the population even though at each age there is a perfect balance between the sexes. The fact that fathers are, on the average, older than mothers tends to produce instability from a fertility standpoint. Thus, for example, in a growing population husbands of a given age are the survivors of relatively fewer births than their wives. The male population is thus relatively underrepresented so that the male net reproduction rate will be higher than the female one. This may be seen in the specific example given in Table III. There the assumed population is based on an increasing percentage

reduction from the basic stationary population for each age group after age 20 for both men and women. The further arbitrary assumption is made that the births to women in a given quinquennial age group may be taken as applying to men 5 years older.[7] Again the age-specific birth rates for women are those of Table I. For this population the net reproduction rate for men is 106.0 as contrasted to 100.0 for women. Thus immaturity of population[8] may result in a sizable differential.

TABLE III

EFFECT OF IMMATURITY OF POPULATION ON NET REPRODUCTION RATE OF ASSUMED POPULATION*

Age group (1)	Stationary population†		Assumed population*		Assumed birth rate for women‡ (6)	Births to		Birth rate for men** (9)
	Women (2)	Men (3)	Women (4)	Men (5)		Women§ (7)	Men¶ (8)	
15–19	457,285	472,705	457,285	472,705	52	23,779	—	—
20–24	451,278	465,465	428,714	442,192	130	55,733	23,779	53.8
25–29	443,786	456,983	399,407	411,285	120	47,929	55,733	135.5
30–34	435,638	447,679	370,292	380,527	80	29,623	47,929	126.0
35–39	426,397	436,558	341,118	349,246	60	20,467	29,623	84.8
40–44	415,333	422,242	311,500	316,682	20	6,230	20,467	64.6
45–49	401,224	403,407	280,857	282,385	3	843	6,230	22.1
50–54	382,740	378,847	248,781	246,251	—	—	843	3.4

Net reproduction rate based on women†† = 100.0
Net reproduction rate based on men‡‡ = 106.0

* Assumed population is 100 per cent of stationary population (see footnote†) for ages 15–19, 95 per cent for ages 20–24, reducing by 5 per cent for each quinquennial age group to 65 per cent for ages 50–54.

† Based on U. S. White Males and Females 1929–31 Life Tables with 100,000 female and 105,600 male births annually.

‡ These rates are arbitrarily set down.

§ Column 4 times column 6 divided by 1000.

¶ It is arbitrarily assumed that the number of births to men in a given age group is the same as for women 5 years younger.

** 1000 times column 8 divided by column 5.

†† Obtained by cumulative multiplication of columns 2 and 6, the result then being multiplied by .4864 (the proportion of girl births based on a sex ratio at birth of 105.6) and divided by 1,000,000.

‡‡ Obtained by cumulative multiplication of columns 3 and 9, the result then being multiplied by .4864 and divided by 1,000,000. (The proportion of girl births is used since the male stationary population figures of column 3 are based on 105,600 births; the proportion of male births, .5136, divided by 1.056, equals .4864).

As the population matures in the above example, both the male and the female age-specific birth rates cannot remain constant; one or the other must change. The common usage of only the female net reproduc-

[7] In 1936 the average ages of mothers and fathers were 27.0 and 31.5 respectively, or a differential of 4.5 years (calculated from Table M, p. 8, *Birth, Stillbirth, and Infant Mortality Statistics*, 1936).

[8] Incidentally, it may be pointed out that none of the major countries has anywhere near a mature population, although some such as France and the Scandinavian countries more nearly approach this condition than do others such as the United States and Australia.

tion rate in assuming that the female age-specific birth rates will remain constant into the future makes the tacit assumption that the male rates will vary. There seems to be no more logic in such an assumption than in assuming that male rates remain constant with the female rates changing in accordance.

Next, turning our attention to actual figures for the United States, male and female net reproduction rates are presented in Table IV. It should be pointed out that since these figures are for all races combined, they may be open to criticism as pertaining to a non-homogeneous

TABLE IV

NET REPRODUCTION RATES FOR MEN AND WOMEN, ALL RACES COMBINED, 1920–35*

Calendar year	Unadjusted rates		Adjusted rates†		Ratio of male to female rate (per cent)
	Men	Women	Men	Women	
1920	121.8	117.4	131.5	126.8	103.7
1930	106.7	98.7	115.2	106.6	108.1
1935	97.1	89.0	104.9	96.1	109.2

* Based on age-specific birth rates calculated from census data, sex proportion at birth (from census reports), and the applicable U. S. Life Tables (1919–21 for the 1920 calculation, 1929–31 for 1930, and 1935 Metropolitan Table for 1935), with survival rates obtained by weighting white ones by 9 and colored ones by 1.

† Adjusted for under-reporting of births (assuming 92.6 per cent complete).

group. However, there is always the question of how far to sub-divide in order to obtain homogeneity. At any event these rates are crudely indicative of the reproductivity of the country as a whole. Moreover, these data are being used primarily to illustrate the differences resulting in reproduction rates as calculated separately for men and women.

From this table it may be seen that the male rate has always been appreciably higher than the female rate. In 1920 the relative difference was only 4 per cent, whereas for 1930 it was about 8 per cent and for 1935 almost 10 per cent. There has been considerable discussion in demographic literature over the fact that the adjusted net reproduction rate (as calculated for women) fell below 100 shortly after 1930. However, the rate for men is still safely above the replacement level, although it has declined rapidly since 1920. Perhaps the fear that the United States is not currently reproducing itself (based on the female net reproduction rate being below 100) is unfounded since the rate for men is well over 100.[9] It is impossible to say which rate is the true one; perhaps the correct answer lies somewhere between.

[9] Incidentally, the adjusted net reproduction rate for women increased after 1935, being 101.6 for 1938 compared with 96.1 for 1935. Male rates have not been obtained for years after 1935.

The difference between the net reproduction rate as calculated separately for men and women is explained by the variation in the relative proportions of men and women in the population as shown by Table V. The upper portion of the table indicates that at each age between 15 and 35—by far the most important child-bearing period—there were about 2 per cent fewer males than females in both the 1920 and 1930 populations. However, according to the stationary population distribu-

TABLE V

SEX RATIOS* FOR PERSONS IN CHILD-BEARING AGES

Age of women	United States population		1929–31 White Life Tables†
	1920	1930	
Ratio for Men of Same Age‡			
10–14	101.8	102.2	103.6
15–19	98.3	99.4	103.4
20–24	95.3	96.4	103.2
25–29	99.8	97.7	103.0
30–34	104.8	100.1	102.8
35–39	110.1	103.3	102.4
40–44	107.4	107.3	101.7
45–49	117.8	108.9	100.5
50–54	115.3	110.1	99.0
Ratio for Men 5 Years Older§			
10–14	88.7	97.0	102.5
15–19	95.2	92.1	101.8
20–24	95.5	87.8	101.3
25–29	90.8	91.7	100.9
30–34	103.4	102.7	100.2
35–39	88.8	91.3	99.0
40–44	101.9	95.3	97.1
45–49	95.8	92.9	94.4
50–54	85.5	85.3	90.5

* Males per 100 females.

† Based on stationary population supported by 100,000 births annually of which 48,640 are female (corresponding to a sex ratio at birth of 105.6).

‡ I.e., ratio of number of men in given quinquennial age group to number of women in same age group.

§ I.e., ratio of men in next older age group to women in given age group.

tion, there should be about 3 per cent more males because of the greater proportion of male births. This is all the more confusing when it is considered that in the past male immigration has exceeded female immigration. The relative over-representation of women at each age (or conversely the under-representation of men) amounts to about 5 per cent and is a partial cause of the difference between the two net reproduction rates.

The comparison of men and women of the same age in the upper portion of Table V indicates a lack of balance that might be caused by either immigration or misstatement of age. The data in the lower portion of the table in comparing men to women 5 years younger takes into account not only the above two factors but also the immaturity of the population. Thus, whereas for a stationary population the ratios up to age 35 should have shown about 1 per cent more males, actually they indicated as much as 10 per cent less. Therein probably lies the explanation of the differential between the two net reproduction rates. As may be noted for ages 15–34, the 1920 figures are, in general, closer to the stationary population figures than are the 1930 ones. This explains why the differential for the 1920 rates is smaller than that for the 1930 ones.

The three hypothetical cases considered previously throw some light on the difference between the male and female rates for the United States. On the one hand, past immigration being mostly male would tend to make the female rate higher, while on the other hand, deliberate understatement of age by women and the general immaturity of the population would tend to make the male rate higher. Undoubtedly, the effect of the latter two factors has more than offset that of the first. The counterbalancing effect of the immigration factor has been considerably negated in respect to the 1930 and 1935 figures because of the decreasing trend of immigration since 1920. This perhaps explains the increasing differential between the male and female rates.

It is difficult to say categorically whether the male or the female rate should be used in any particular case. Perhaps the most adequate method of analysis is to utilize the two rates as a range within which the "true" value must lie rather than merely using the female rate as is commonly done.

THE RELATION BETWEEN THE DESIGN OF AN EXPERIMENT AND THE ANALYSIS OF VARIANCE

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I do not propose to present any new designs or any new relations between the design of an experiment and the analysis of the results but rather to present some of these relations in a way that has helped me to gain a fuller understanding of various designs and the analysis of variance appropriate to them. In addition, I believe this method of presentation has enabled me to assist some of my students to gain a more complete understanding of these useful tools.

In the beginning of our study of the analysis of variance, if but one criterion of classification were involved, most of us were able to calculate separately the total sum of squares and the two partitions of it, that is, the sum of squares "between groups" and the sum of squares "within groups." As for the number of degrees of freedom corresponding to each sum of squares we learned a rule which might be called the rule of "one less." Thus, the total number of degrees of freedom was one less than the total number of observations and the number for "between groups" was one less than the number of groups. A bit more difficulty was met in applying this rule to the within group partition, since it had to be applied to the groups separately and the results summed, hence the more convenient scheme of subtracting the number of degrees of freedom for "between groups" from the total number came into rather common use. If the number of groups was at all large, this convenient scheme of subtracting was used to determine the "within group" sum of squares as well. As the experiments became more complex some of us calculated the total sum of squares and the several easily computed partitions of it and then, by subtraction, lumped what was left and frequently labeled it remainder.

Snedecor (6) in his little book *Calculation and Interpretation of Analysis of Variance and Covariance*, which has been out of print for some time, has done just this in example 3. In fact he says, "There is no practical way of verifying the foregoing computations save by repetition." Other means of calculation are, of course, now known. One which appeals to me as convenient and illuminating involves the evaluation of the individual degrees of freedom. These are variously known as partitions of rank one, quadratic forms of rank one, independent compari-

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TABLE I
CALCULATION OF PARTITIONS OF TOTAL SUM OF SQUARES APPROPRIATE TO EACH DEGREE OF FREEDOM

		1913		1915		1917		1923		1929		Sums	Divisors	$\frac{(\text{Sum})^2}{\text{divisor}}$
		A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*			
		16.51	12.92	39.99	40.87	19.86	19.03	22.36	20.76	14.87	13.28			
Comparisons														
Variety	V	+	−	+	−	+	−	+	−	+	−	6.73	10	4.529
Year	Y_1	+	+	−	−							−51.43	4	661.261
	Y_2	+	+	+	+	−2	−2					32.51	12	88.075
	Y_3	+	+	+	+	+	+	−3	−3			19.82	24	16.368
	Y_4	+	+	+	+	+	+	+	+	−4	−4	79.70	40	158.802
Interaction	$V \times Y_1$	+	−	−	+							4.47	4	4.995
	$V \times Y_2$	+	−	+	−	−2	+2					1.05	12	.092
	$V \times Y_3$	+	−	+	−	+	−	−3	+3			−1.26	24	.066
	$V \times Y_4$	+	−	+	−	+	−	+	−	−4	+4	−1.22	40	.037
												90.37	170	
	Check	+9	−	+5	−	+	−	−3	−	−7	−	90.37	170	

Summary of Analysis

Comparison	*D/F*	Sum of squares
Variety	1	4.529
Year	4	924.507
Variety × year	4	5.190
Total	9	934.226

sons, orthogonal comparisons, individual comparisons and individual degrees of freedom. Cochran (1), Snedecor (7), Fisher (3), Irwin (4), Yates (8), Craig (2), Madow (5), and others have discussed these forms. To illustrate, I shall use the yields in bushels per acre of two varieties of corn, *A* and *B*, grown on acre plots in five different years. The data, indicated computations, and results are given in Table I.

Each row in the table represents a function of the individual yields which serves as a guide in calculating the sums in the second from the last column. Each row except the last represents an independent comparison between these individual yields. The coefficients in the last row are secured by adding those in the columns immediately above and make up a function which provides a partial check on the accuracy of the second from last and next to last columns. The sum of the divisors must check with the sum of the squares of the coefficients in the last row. The sum of the sums must check with the algebraic sum of the individual yields indicated by the function in the check row. The divisors are the sums of the squares of the coefficients in the corresponding function. The sum for any row is the algebraic sum of the individual yields indicated by the function in that row. The total sum of squares in the summary must check with the total sum of squares calculated from the 10 yields as follows:

$$(16.51)^2+(12.92)^2+\cdots+(13.28)^2-(220.45)^2/10$$
$$=5794.0465-4859.8202=934.2263$$

In factorial experiments other partitions of the total sum of squares become important and it becomes necessary to isolate them. Yates (8) in *The Design and Analysis of Factorial Experiments* presented a factorial experiment on potatoes which involved two levels of nitrogen, two of potash, and two of barnyard manure or 8 treatment combinations in all. The field plan consisted of 4 replicates in randomized blocks. The structure of this experiment may be specified by the following subdivision of the total number of degrees of freedom:

TABLE II

Comparisons	*D/F*
Blocks	3
Treatments	7
Error (block×treatment)	21
Total	31

However, the factorial design makes it possible to isolate each of the 7 degrees of freedom for treatment.

TABLE III
INDIVIDUAL COMPARISONS AND CALCULATIONS FOR

Block treatment yield			I								II								
			(1) 101	n 106	k 265	nk 291	m 312	nm 373	km 398	nkm 450	(1) 87	n 128	k 279	nk 334	m 323	nm 324	km 423	nkm 471	(1) 106	
Comparisons																			
Blocks		B_1	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	
		B_2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−2	−
		B_3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Treatment	N		−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	
	K		−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	−	
	M		−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−	
	NK		+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	
	NM		+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	+	
	KM		+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	
	NKM		−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	
Error	N	B_1	−	+	−	+	−	+	−	+	+	−	+	−	+	−	+	−		
	N	B_2	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	+2	−
	N	B_3	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	
	K	B_1	−	−	+	+	−	−	+	+	+	+	−	−	+	+	−	−		
	K	B_2	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	+2	+
	K	B_3	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	−	
	M	B_1	−	−	−	−	+	+	+	+	+	+	+	+	−	−	−	−		
	M	B_2	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	+2	+
	M	B_3	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−	
	NK	B_1	+	−	−	+	+	−	−	+	−	+	+	−	−	+	+	−		
	NK	B_2	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	−2	+
	NK	B_3	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	
	NM	B_1	+	−	+	−	−	+	−	+	−	+	−	+	+	−	+	−		
	NM	B_2	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	−2	+
	NM	B_3	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	+	
	KM	B_1	+	+	−	−	−	−	+	+	−	−	+	+	+	+	−	−		
	KM	B_2	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	−2	−
	KM	B_3	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+
	NKM	B_1	−	+	+	−	+	−	−	+	+	−	−	+	−	+	+	−		
	NKM	B_2	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	+2	−
	NKM	B_3	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+
	Check		−	−	−	−	−	−	−	+31	−	−	−	−	−	−	−	+15	−	−

Calculation of total sum of squares

$\Sigma x =$ 9331
$n =$ 32
$\bar{x} =$ 291.59375
$\Sigma x^2 =$ 3187641.00000
$(\Sigma x)^2/n =$ 2720861.28125

$\Sigma(x-\bar{x})^2 =$ 466779.71875

III

FOR RANDOMIZED BLOCK EXPERIMENT

III								IV								Sum	Sum of squares Divisor	$\frac{(\text{Sum})^2}{\text{Divisor}}$	Effects Divisor	$\frac{\text{Sum}}{\text{Divisor}}$ or effect in lbs. per plot or bushels per acre
(1) 106	*n* 89	*k* 272	*nk* 306	*m* 324	*nm* 338	*km* 407	*nkm* 449	(1) 131	*n* 103	*k* 302	*nk* 272	*m* 324	*nm* 361	*km* 445	*nkm* 437					
																−73	16	333.06		
−2	−2	−2	−2	−2	−2	−2	−2									83	48	143.52		
+	+	+	+	+	+	+	+	−3	−3	−3	−3	−3	−3	−3	−3	−169	96	297.51		
−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	333	32	3465.28	16	20.8
−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	2271	32	161170.03	16	141.9
−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	2987	32	278817.78	16	186.7
+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	105	32	344.53	16	6.6
+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	161	32	810.03	16	10.1
+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	−669	32	13986.28	16	−41.8
+	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	−63	32	124.03	16	−3.9
																−1	16	0.06		
+2	−2	+2	−2	+2	−2	+2	−2									143	48	426.02		
+	−	+	−	+	−	+	−	+3	−3	+3	−3	+3	−3	+3	−3	449	96	2100.01		
																−133	16	1105.56		
+2	+2	−2	−2	+2	+2	−2	−2									3	48	0.19		
+	−	−	+	+	−	−	+	+3	+3	−3	−3	+3	+3	−3	−3	123	96	157.59		
																57	16	203.06		
+2	+2	+2	+2	−2	−2	−2	−2									−7	48	1.02		
+	−	−	−	+	+	+	+	+3	+3	+3	+3	−3	−3	−3	−3	−49	96	25.01		
																−49	16	150.06		
−2	+2	+2	−2	−2	+2	+2	−2									−85	48	150.52		
+	−	−	+	+	−	−	+	−3	+3	+3	−3	−3	+3	+3	−3	293	96	894.26		
																129	16	1040.06		
−2	+2	−2	+2	+2	−2	+2	−2									−43	48	38.52		
+	−	+	−	−	+	−	+	−3	+3	−3	+3	+3	−3	+3	−3	−187	96	364.26		
																−35	16	76.56		
−2	−2	+2	+2	+2	+2	−2	−2									41	48	35.02		
+	+	−	−	−	−	+	+	−3	−3	+3	+3	+3	+3	−3	−3	−97	96	98.01		
																−63	16	248.06		
+2	−2	−2	+2	−2	+2	+2	−2									49	48	50.02		
+	−	+	+	−	+	−	−	+	+3	−3	−3	+3	−3	+3	+3	−3	109	96	123.76		
																5613	1504			
+15	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−17	5613	1504			

Summary of analysis of variance

	D/F	Sum of squares
Blocks	3	774.09
N	1	3465.28
K	1	161170.03
M	1	278817.78
NK	1	344.53
NM	1	810.03
KM	1	13986.28
NKM	1	124.03
Error	21	7287.63
Total	31	466779.68

Yates has done this fully. In so doing he placed in a table the signs indicating the algebraic sums from which the individual treatment comparisons may be computed. I shall use an extension of this table for all the computations presented by Yates and to show the relation between the design of this $2\times2\times2$ factorial experiment and the analysis of variance appropriate to it. The indicated operations and the completed calculations for each of the 31 appropriate comparisons among the 32 plot yields are given in Table III.

From the many possible sets of comparisons among the 4 main block totals, I have selected one which is easily formed. Thus, for one degree of freedom, the total yield for block II is subtracted from that for block I, for a second, twice the total yield of block III is subtracted from the total of blocks I and II, and for the third, three times the sum of the yield of block IV is subtracted from the sum of the yields of blocks I, II, and III. By a similar scheme, the signs may be written for the 3 main effects. Thus, for effect of nitrogen, all plots receiving nitrogen are given a plus sign and all those not receiving nitrogen a minus sign and similarly the signs are assigned for potash and barnyard manure. Since the remaining 25 degrees of freedom are secured by multiplying one or more of these 6 together they should be checked carefully. The first condition that must be fulfilled is that the sum of the coefficients in any line must be zero. The second is that the sum of the products of corresponding coefficients in each combination of two lines must be zero.

These conditions being fulfilled, the remaining 4 treatment comparisons are derived from the 3 main effect comparisons by multiplication. Thus, the comparison for the interaction which involves nitrogen and potash (NK) is formed by multiplying the coefficients in the N line by the corresponding ones in the K line; that for the interaction between nitrogen and barnyard manure (NM) is formed by multiplying the coefficients in the N line by the corresponding ones in the M line; that for the KM is formed by multiplying the coefficients in the K line by the corresponding ones in the M line; and the comparison for the triple interaction (NKM) may be formed by taking the product of corresponding coefficients in the three lines, N, K, and M or by multiplication of corresponding coefficients in one of the following combinations of lines N and KM, K and NM, or M and NK. These 4 new comparisons must be checked to make certain they fulfill the two criteria given above.

The estimate of error in this example is based on the failure of the treatments to produce the same result in the different blocks, that is, on the interaction of treatments and blocks. The comparisons for error, then, are formed by multiplication just as the treatment interactions

were above. Each of the 7 treatment comparisons is multiplied term by term by each of the 3 block comparisons to produce the 21 error comparisons. Before proceeding further the 31 comparisons must be checked to be sure they fulfill the two given criteria.

Having determined that the 31 functions are orthogonal the check function is formed by summation. As in Table I, the sum for any row is the algebraic sum of the individual yields indicated by the function in that row and the sum of squares divisor for any row is the sum of squares of the coefficients in that row. Another column of divisors, which may be called the effects divisors, is added for obtaining the main effects and interactions in the sense used by Yates (8). An effects divisor for any row is the sum of the positive coefficients in that row or, what amounts to the same thing, one-half the sum of the absolute values of the coefficients.

The treatment sums are identical with those given by Yates (8) in Table 7. The effects which are given here in bushels per acre, if converted to English tons per acre also agree with those given by Yates. The results of the analysis of variance are given in the Summary of Analysis. The total of the sums of squares must check with the total sum of squares calculated directly from the individual yields. Thus, each of the 31 degrees of freedom has been calculated in an easy and convenient manner. These are easily assembled to produce a typical analysis of variance summary. However, the greatest value of this presentation is not as an aid to computation but as a means of explaining just what an orthogonal comparison is, its correspondence to a degree of freedom, and the unique relation between the form of analysis and an experimental arrangement or design.

This method of presentation has been especially helpful in dispelling the confusion which the device known as confounding has produced in some of my students and co-workers. To illustrate, we will do as Yates (8) did, reconstruct the analysis of this experiment on the supposition that it was designed so as to confound the triple interaction with blocks and that the resulting yields were identical with those obtained. This arrangement is indicated in Table IV. All the comparisons in Table III have been put in Table IV with the addition of 4 more for blocks to provide 7 comparisons or degrees of freedom for the 8 blocks.

We now appear to have 35 comparisons or degrees of freedom. This is due to the fact that not all are independent or orthogonal as shown by the failure of the check function to check. Upon examination, we find that the contribution to the total sum of squares corresponding to the triple interaction, NKM, is identical with that for the fourth partition for blocks. This comparison must be deleted from treatments since

TABLE IV
INDIVIDUAL COMPARISONS AND CALCULATIONS FOR RA

Block treatment yields			I *A*				I *B*				II *A*				II *B*				
			(1) 101	*nk* 291	*nm* 373	*km* 398	*n* 106	*k* 265	*m* 312	*nkm* 450	(1) 87	*nk* 334	*nm* 324	*km* 423	*n* 128	*k* 279	*m* 323	*nkm* 471	(1) 106
Comparisons																			
Blocks		B_1	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	
		B_2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−2
		B_3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
		B_4	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−
	$B_4 \times B_1$		−	−	−	−	+	+	+	+	+	+	+	+	−	−	−	−	
	$B_4 \times B_2$		−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	+2
	$B_4 \times B_3$		−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−
Treatments	N		−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−
	K		−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
	M		−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	−
	NK		+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+
	NM		+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	+
	KM		+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
	NKM		−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−
Error	N	B_1	−	+	+	−	+	−	−	+	+	−	−	+	−	+	+	−	
	N	B_2	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	+2
	N	B_3	−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−
	K	B_1	−	+	−	+	−	+	−	+	+	−	+	−	+	−	+	−	
	K	B_2	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	+2
	K	B_3	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
	M	B_1	−	−	+	+	−	−	+	+	+	+	−	−	+	+	−	−	
	M	B_2	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	+2
	M	B_3	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	−
	NK	B_1	+	+	−	−	−	−	+	+	−	−	+	+	+	+	−	−	
	NK	B_2	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	−2
	NK	B_3	+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+
	NM	B_1	+	−	+	−	−	+	−	+	−	+	−	+	+	−	+	−	
	NM	B_2	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	−2
	NM	B_3	+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	+
	KM	B_1	+	−	−	+	+	−	−	+	−	+	+	−	−	+	+	−	
	KM	B_2	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	−2
	KM	B_3	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+
	NKM	B_1	−	−	−	−	+	+	+	+	+	+	+	+	−	−	−	−	
	NKM	B_2	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	+2
	NKM	B_3	−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−
	Check		−5	−5	−5	−5	+3	+3	+3	+35	−3	−3	−3	−3	+	+	+	+17	−1

Summary of analysis

	D/F	Sum of squares
Blocks	7	1319.97
N	1	3465.28
K	1	161170.03
M	1	278817.78
NK	1	344.53
NM	1	810.03
KM	1	13986.28
Error	18	6865.79
Total	31	466779.69

IV

RANDOMIZED BLOCK EXPERIMENT WITH CONFOUNDING

III *A*				III *B*				IV *A*				IV *B*				Sum	Sum of squares Divisor	(Sum)²/Divisor Individual contribution to total sum of squares
(1) 106	*nk* 306	*nm* 338	*km* 407	*n* 89	*k* 272	*m* 324	*nkm* 449	(1) 131	*nk* 272	*nm* 361	*km* 445	*n* 103	*k* 302	*m* 324	*nkm* 437			
																−73	16	333.06
−2	−2	−2	−2	−2	−2	−2	−2									83	48	143.52
+	+	+	+	+	+	+	+	−3	−3	−3	−3	−3	−3	−3	−3	−169	96	297.51
−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−63	32	124.03
																−63	16	248.06
+2	+2	+2	+2	−2	−2	−2	−2									49	48	50.02
−	−	−	−	+	+	+	+	+3	+3	+3	+3	−3	−3	−3	−3	109	96	123.76
−	+	+	−	+	−	−	+	−	+	+	−	+	−	−	+	333	32	3465.28
−	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	2271	32	161170.03
−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+	2987	32	278817.78
+	+	−	−	−	−	+	+	+	+	−	−	−	−	+	+	105	32	344.53
+	−	+	−	−	+	−	+	+	−	+	−	−	+	−	+	161	32	810.03
+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	−669	32	13986.28
−	−	−	−	+	+	+	+	−	−	−	−	+	+	+	+	−63	32	124.03
																−1	16	0.06
+2	−2	−2	+2	−2	+2	+2	−2									143	48	426.02
−	+	+	−	+	−	−	+	+3	−3	−3	+3	−3	+3	+3	−3	449	96	2100.01
																−133	16	1105.56
+2	−2	+2	−2	+2	−2	+2	−2									3	48	0.17
−	+	−	+	−	+	−	+	+3	−3	+3	−3	+3	−3	+3	−3	123	96	157.59
																57	16	203.06
+2	+2	−2	−2	+2	+2	−2	−2									−7	48	1.02
−	−	+	+	−	−	+	+	+3	+3	−3	−3	+3	+3	−3	−3	−49	96	25.01
																−49	16	150.06
−2	−2	+2	+2	+2	+2	−2	−2									−85	48	150.52
+	+	−	−	−	−	+	+	−3	−3	+3	+3	+3	+3	−3	−3	293	96	894.26
																129	16	1040.06
−2	+2	−2	+2	+2	−2	+2	−2									−43	48	38.52
+	−	+	−	−	+	−	+	−3	+3	−3	+3	+3	−3	+3	−3	−187	96	364.26
																−35	16	76.56
−2	+2	+2	−2	−2	+2	+2	−2									41	48	35.02
+	−	−	+	+	−	−	+	−3	+3	+3	−3	−3	+3	+3	−3	−97	96	98.01
																−63	16	248.06
+2	+2	+2	+2	−2	−2	−2	−2									49	48	50.02
−	−	−	−	+	+	+	+	+3	+3	+3	+3	−3	−3	−3	−3	109	96	123.76
																5645	1696	467325.55
−1	−1	−1	−1	−1	−1	−1	−1	+1	+1	+1	+1	−3	−3	−3	−19	5069	2080	

it has been confounded with blocks by the design. Likewise the last three contributions to error which are interactions involving *NKM* and original blocks have been confounded and must be deleted from error. The analysis of variance may now be summarized as shown in Table IV.

The device known as partial confounding offers further use for this method of presentation. Some students and also some experimenters find it difficult to determine the arrangement of treatments in sub-blocks which will produce the partial confounding of the desired interactions or to determine which interactions are partially confounded by a given arrangement. In arranging the treatments totally to confound the triple interaction as may be observed in Table IV, the fertilizer treatments were assigned so that all minus terms of the triple interaction functions would fall in sub-blocks *IA*, *IIA*, *IIIA*, and *IVA*, and all plus terms in *IB*, *IIB*, *IIIB*, and *IVB*. Partially to confound the *NKM* interaction in blocks *IA* and *IB*, the *NK* interaction in blocks *IIA* and *IIB*, the *NM* interaction in blocks *IIIA* and *IIIB*, and the *KM* interaction in blocks *IVA* and *IVB*, requires only that the plus and minus terms for an interaction be grouped in the desired pair of sub-blocks.

I have attempted to show how the tabulation of individual comparisons may assist one in understanding and in helping others to understand various experimental designs and the corresponding appropriate analyses. Though the scheme may be used as a form of computation, it becomes cumbersome when the number of comparisons becomes large. However, for a reasonable number of observations, the table of comparisons can be set up in such a manner, when the experiment is designed, that the analysis of the results becomes a matter of mere routine calculations.

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SOME PRACTICAL USES FOR HYPERBOLIC GRIDS

By Herbert G. Smith[1]

So much statistical work is performed with approximate data that this writer has long held the opinion that approximate methods also are frequently justified, both for treating the data and for rough checking purposes. Again, where approximate solutions will serve, these may, in many instances, be obtained readily and easily by graphic methods, particularly where the functions considered will plot to straight lines, making interpolation easy.[2]

Hyperbolic, or reciprocal, grids are a relatively unknown and, for that reason, rarely used type of graph upon which certain functions will plot either as a continuous linear curve or as a broken series of linear curves. For rate studies and for purposes of obtaining weighted arithmetic averages graphically, the hyperbolic grid will frequently render great service. The justification of the present paper is that nearly all standard texts on graphics seem to ignore the hyperbolic grid entirely, or give it inadequate treatment. Perhaps the best generally available explanation of this graph and its usage occurs respectively in the graph paper catalogs of Keuffel & Esser Company, Inc., and of the Codex Book Company, Inc.; and, in the latter, references are made to two articles and to a Codex leaflet which further describe the uses of the hyperbolic grid. To whom should go the credit for having devised this type of graph seems to be unknown, for the present author has nowhere been able to note reference to its originator.

Ready-prepared hyperbolic graph papers, conventionally on paper $8\frac{1}{2} \times 11$ in size, may be obtained from manufacturers of graph papers, and, on these commercial papers, rulings are sufficiently numerous to provide for reasonably accurate plotting and interpolation. The horizontal axis, or axis of abscissas, is calibrated according to the reciprocals of the numbers printed on this scale. The vertical scale, or axis of ordinates, is customarily graduated arithmetically, and the numerical values given to these graduations may be large or small as desired. The vertical scale is graduated from zero (0) in both positive and negative directions, if desired; the horizontal scale conventionally begins with unity (1) and is calibrated positively to the right to infinity (∞).

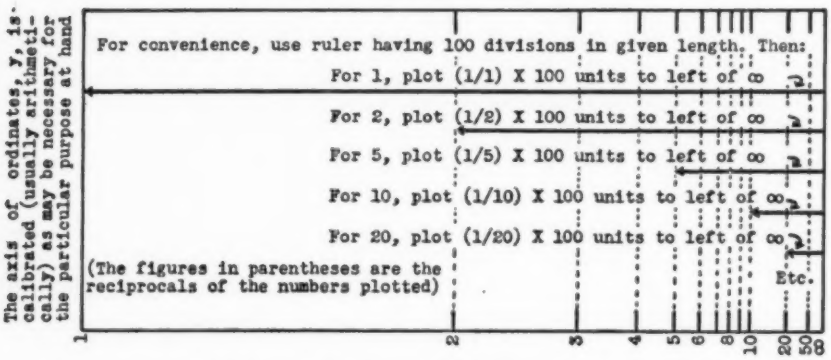
[1] The writer wishes to acknowledge the courtesy of Mr. R. von Huhn, Washington, D.C., who kindly read and criticised the first draft of this paper, and some of whose suggestions have been incorporated in this revision.

[2] See, for example, the writer's *Figuring with Graphs and Scales*, Stanford University Press, 1938, a small treatise devoted largely to explanations and illustrations of logarithmic graphs and scales for "figuring."

By plotting various functions of x (that is, the y's) to infinity on the abscissa scale, the weighted mean over any abscissa designation may be found for the ordinate values up to that abscissa point. This is because the various means lying on any one given straight line, if plotted through converge upon the same point at infinity. The same results

FIGURE I

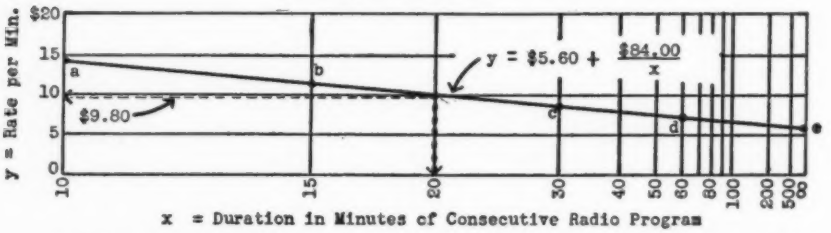
LAYOUT OF RECIPROCAL SCALE


The axis of ordinates, y, is calibrated (usually arithmetically) as may be necessary for the particular purpose at hand
For convenience, use ruler having 100 divisions in given length. Then:
For 1, plot (1/1) X 100 units to left of ∞
For 2, plot (1/2) X 100 units to left of ∞
For 5, plot (1/5) X 100 units to left of ∞
For 10, plot (1/10) X 100 units to left of ∞
For 20, plot (1/20) X 100 units to left of ∞
(The figures in parentheses are the reciprocals of the numbers plotted)
Etc.
1
2
3
4
5
6
8
10
20
50
∞

The axis of abscissas, x, is normally the reciprocal scale. Figures may be used as they appear, or as they would appear if each were multiplied or divided by an integral power of 10. Normal range is from 1.00 to ∞ (infinity), but fractional quantities may be shown. Intermediate calibrations are not shown here, but may be added as circumstances indicate.

FIGURE II

RADIO TIME RATES



Published Rates and Plotting Points

Published Rates	Minutes x	Rate per Min. y
1 Hour $420	60	$ 7.00
½ Hour 252	30	8.40
¼ Hour 168	15	11.20
⅛ Hour 140	10	14.00

(1) These data exhibit a linear relationship on this type of grid, converging upon the same point at infinity. The xy points for plotting are located as on any type of grid, and the curve is projected to infinity.

(2) Any function that is linear on this type of grid may be represented by the general equation $y=a+b/x$, where y represents ordinate numerical values, a is the y-intercept at infinity, x represents abscissa numerical values, and b is a constant.

(3) Merely by substituting $1/x$ for x in the conventional arithmetic linear equation, $y=a+b\,x$, a *particular* equation may be found by the wellknown method of least squares. As an illustration of

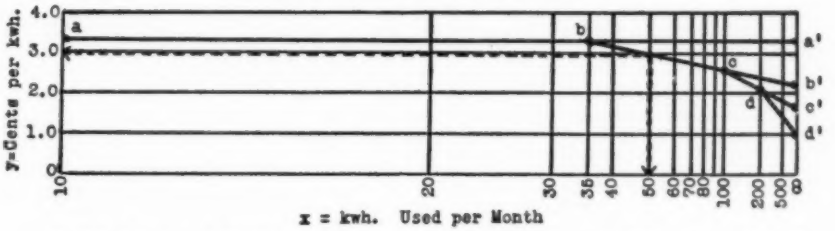
(4) use, above 20 minutes on graph interpolate $9.80—the rate per minute for a consecutive radio program of 20 minutes duration.

may, of course, easily be obtained by ordinary computation, yet, as will be noted below, once the graphic process is understood it will frequently be found to be a very rapid method and will yield results sufficiently precise for approximate purposes. Further, as in the case of electric rates, below, for example, once the rates are plotted the graph may be retained and the average rate for a given usage may, whenever desired, be approximated easily and quickly from the graph.

Figure II, Radio Time Rates. The radio rates given in conjunction with Figure II, and adapted for plotting thereon, are from the recent rate schedule of a prominent West Coast station and are fairly representative of common radio rate structures. Although the rate card lists only the rates given, if it is assumed that rates for intermediate periods of time are arrived at by similar processes, then, easily and readily, they may be interpolated from Figure II without computation.

FIGURE III

"BLOCK-METER" ELECTRIC RATES



Published Rates and Plotting Points

Number of kwh. Used per month		Cumulated kwh. x	Cents per kwh. y
First	35	35	3.3
Next	65	100	2.2
Next	100	200	1.6
Over	200	Over 200	1.0

(1) From origin to infinity, draw horizontal line aa' at 3.3¢. This rate applies to all usage up to 35 kwh. per month, inclusive.

(2) From 35 kwh. on the 3.3¢ curve to 2.2¢ at infinity, draw line bb', and average rate per kwh. for usages from 35 kwh. to 100 kwh. may be interpolated from bb'.

(3) Draw curve cc' from bb' and 100 kwh. to 1.6¢ and infinity. Average rates for usage from 100 kwh. to 200 kwh. lie on curve cc'.

(4) Draw curve dd' from cc' and 200 kwh. to 1.0¢ and infinity. Average rates for usage over 200 kwh. per month lie on curve dd'.

(5) Illustration: The dotted lines indicate for 50 kwh. per month an average rate just under 3.0¢.

Figure III, Block-Meter Electric Rates. Perhaps it is in the field of electric and gas rates that the so-called "classical" use of hyperbolic grids may be found. In any event, it is to these fields that their use has, so far, largely been restricted.

The domestic lighting rates given in conjunction with Figure III and adapted for plotting thereon, are those recently published for a relatively small Pacific Coast municipal utility. The average rate per kwh. for a usage of 150 kwh. per month, for example, would ordinarily be

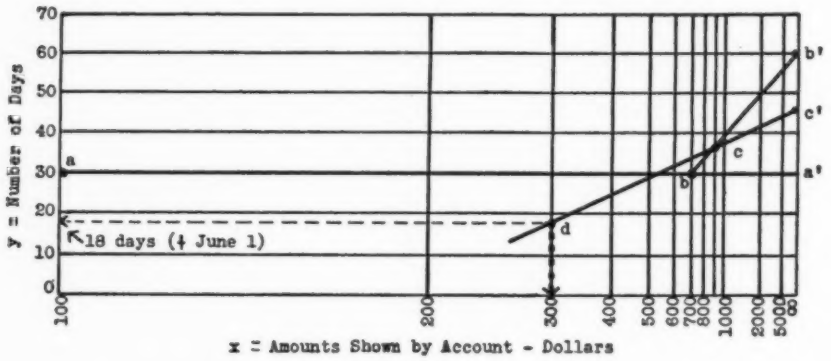
found in the following manner, similar to that for determining any weighted average:

$$\frac{35 \text{ kwh.} \times 3.3¢ + 65 \text{ kwh.} \times 2.2¢ + 50 \text{ kwh.} \times 1.6¢}{150 \text{ kwh.}}, \text{ or}$$

$$\frac{\$1.155 + \$1.430 + \$0.80}{150}, \text{ or } 2.26 - ¢.$$

How much more easy it is merely to glance at the graph, once the data are plotted, and to determine visually that the approximate aver-

FIGURE IV
AVERAGING ACCOUNTS



The Account and Plotting Points

Date	Due	Amount	Cumulated Amounts x	Days from June 1 y
6/1	7/1	$700 dr	$700	30
6/1	8/1	200 dr	900	60
6/1	7/17	600 cr	300	46

(1) From origin to infinity, draw horizontal line aa' at 30 days. The $700 item lies on this line.

(2) From $700 on aa' draw bb' to 60 days and infinity. The $900 sum lies on this line.

(3) From $900 on bb' draw cc' to 46 days and infinity, projecting cc' backwards to beyond d, so that the sum $300 will lie on this line.

(4) Over $300, interpolate horizontally to the left-scale the number of days from June 1 (focal date) to average date. The dotted lines indicate that this is 18 days.

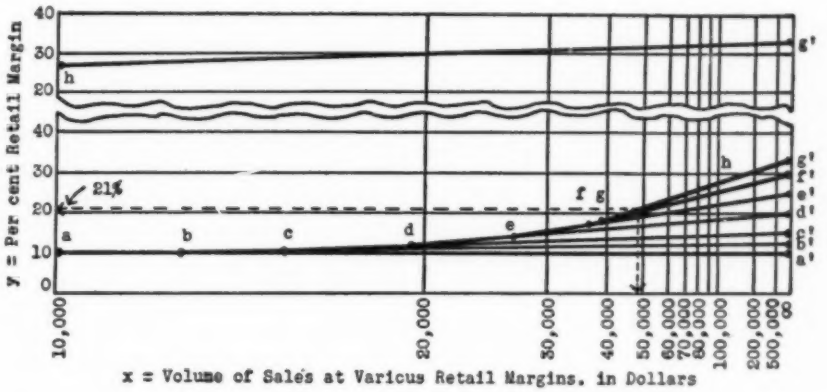
age rate is about 2.25¢ per kwh.! And the plotting, itself, once the use of the graph is grasped, takes considerably less time than does the foregoing computation.

Figure IV, Averaging Accounts. Statistics has often been defined broadly as being the "handmaiden of accountancy." Here's one place—rather unconventional—where they can work hand in hand. A reasonably simple problem in weighted averages, "averaging an account" is, as illustrated with hypothetical data on Figure IV, even more simple graphically.[3]

Figure V, Equalizing Sales and Margins. Federal enabling laws, such as the Miller-Tydings Act, were designed to eliminate the popular retail-store practice of price-leaders, sold at or below cost. Recent difficulties in Colorado, where in conforming to State law certain merchants ran afoul of Federal law indicate that these enabling laws are not wholly effective. An article in the *Radford Grocery News* for November 1940,[4]

FIGURE V

EQUALIZING SALES AND MARGINS



Sales and Plotting Points

Sales by Departments	Cumulated Sales x	Retail Margin y
$12,000	$12,000	10 %
2,400	14,400	12½ %
4,800	19,200	15 %
7,200	26,400	20 %
9,600	36,000	25 %
2,400	38,400	30 %
9,600	48,000	33⅓ %

(1) From origin (left-margin) to infinity, draw horizontal line aa' at 10%. This line represents average per cent retail margin on sales volume up to $12,000.

(2) From $12,000 on curve aa', draw bb' to infinity and 12½%. On this curve, bb' lie sales volumes from $12,000 to $14,400, inclusive.

(3) In similar fashion, from data in table herewith, draw curves cc', dd', ee', ff' and gg'.

(4) Then, from the graph, for any volume of sales segregated as in the table, the average rate of margin for that volume may be interpolated. Thus, if the average retail margin for the store's total sales ($48,000) is desired, this margin which is approximately 21%, may be read. (See dotted lines.)

(5) In connection with Figure I, it was mentioned that figures on the axis of abscissas may be used as they appear or, depending upon circumstances, as they might appear were each multiplied or divided by an integral power of 10 . . . . The upper section (broken) of the accompanying graph is a repetition of the upper part of the lower section, but with figures on the axis of abscissas presumed to be multiplied by 10 in each instance. The curve hg' on this upper section, then, is a repetition in less condensed form of that portion of curve gg' on lower section lying between h and g'; that is, between $100,000 and infinity. In similar fashion, scales approaching infinity may be expanded so as to facilitate plotting and reading.

[3] For the ordinary method of computation, the reader is referred to almost any text of intermediate or higher grade on accountancy. Here, other than for the graphic outline, space is wanting for a more complete description.

[4] External house organ published monthly for customers of the J. M. Radford Grocery Company, a Texas company operating a chain of wholesale outlets in the Southwest.

explaining for the benefit of grocers how they may manipulate their margins relative to sales so as to sell some merchandise at cost and yet average a desired margin on all sales, offers another instance.

Figures presented in connection with Figure V and adapted for use thereon, are borrowed from a table appearing in *Progressive Grocer*, New York, for March 1935, illustrating an article entitled "How Grocery Products May Be Marked Up to Average 20% on Sales." As with the averaging process outlined in connection with electric rates, above, the problem here is again one of obtaining a weighted average. But, again, once the use of the graph is understood, the process, for approximate purposes, may be carried out much more quickly by using a ready-prepared hyperbolic grid.

Other Uses. There are many instances in which the use of a hyperbolic grid for "figuring" will save time and temper and will promote accuracy. In other instances, this type of graph can render a complementary service, namely, that of providing for a reasonably accurate rapid check on computation performed in the ordinary manner. Several suggested uses follow:

(1) The five-day week at schedule wages, with time-and-one-half for overtime is becoming prevalent. In many instances it is important to know what the average rate of pay is per hour under such conditions. By adaptation of methods illustrated here, a hyperbolic graph will supply this information quickly and easily.

(2) What is the average rate of turnover of merchandise in a given store of several departments, the turnover rate being different in each department? This, again, is a simple showing on a hyperbolic grid, being a problem almost exactly similar to the one of equalizing sales and margins, Figure V.

(3) Another interesting usage, comparable to the block-meter electric rates as illustrated, is in connection with income tax. If an income tax schedule listing "amounts of surtax net income" and "rate per cent" is examined, it will be noted that they are arranged in blocks, just as are the electric rates described. And as with the electric rates, these income tax figures may be plotted on hyperbolic paper so as to show, for any "amount of surtax net income," *one* percentage figure applying to it. *Caution:* This usage is suggested merely as a check on other computation; the results obtained graphically are not sufficiently precise to serve alone. For reporting figures, one must continue to use those necessarily obtained by the tedious computation of "total surtax" block by block.

NOTES AND DISCUSSIONS

Methods of Family Living Studies, A Reply to the Review

Though Professor Zimmerman seems to disqualify himself as a reviewer of *Methods of Family Living Studies* by confessing his contempt for budget investigators, readers of the review in the December number of this JOURNAL may gain an entirely false impression of the report, which, except for a short chapter on purposes of family living studies, is devoted exclusively to methods. The statement is made in the review that the appendix contains "tabular material concerning the 36 illustrative studies, so that the student may compare his findings with those of others." The appendix contains no findings, but merely shows what detail of method is followed in the different studies analyzed. The findings of these recent family living studies are summarized in two articles in the May and June numbers of the *International Labour Review* for 1939, and referred to in the preface and elsewhere in the report.

The reviewer remarks that the document was "supposedly printed to inspire the development of similar studies in other regions and other countries." In fact, it was prepared to be of assistance to those who were carrying out such studies.

Professor Zimmerman would like to know what a year of average prosperity is, apropos of a statement that in planning budget studies a year of average prosperity is usually chosen. It should be sufficiently clear that since the period is chosen in advance, the year of average prosperity merely avoids the extremes of prosperity and depression. Since official family living studies in the great majority of cases are made with a view, among other purposes, to furnishing a base for cost of living indices, the reason for avoiding extremes is clear.

Professor Zimmerman adds some generalizations as to "lack of originality," lack of explanations in terms of principles, and saying "what has been said *ad nauseum*" (sic): the only evidence offered is the remark thus cited in regard to average prosperity. He adds the query, "Why can't social scientists be encouraged to study life as it is?" Does the reviewer mean to suggest that family budget investigators study family living as it is not?—a chief preoccupation of modern studies (brought out in the report) is the emphasis upon sampling to make sure that details of family living as found in the families studied are representative and significant. Or does he mean to support the principle that the family budget investigator should issue forth without plan or method and study "life as it is?" Is this the originality that the reviewer fails to find in the report? In any case, the report does not purport to cover "life" but merely family "living" with its economic meaning and limitations.

The final sentence in the last paragraph of the review and the bold generalization that leads up to it may be considered as specimens by which to

judge the quality of the reviewer's generalizations. "The reviewer is of the opinion that . . . the average outlook of the budget investigator is not up to that of the Political Arithmeticians. The reason is due in part to official reports such as this." For this generalization in regard to the average outlook of the budget investigator no evidence is presented; no indication is given as to whether the conclusion is based on a sample or on a complete analysis; no method is apparent by which an average outlook can be calculated—how the outlooks of budget investigators in the front rank, like Faith Williams and Ernst Abramson for example, can be averaged with benighted outlooks more restricted than those of the Political Arithmetician to yield an average result "not up to that of the Political Arithmeticians." But the crucial defect in the generalization is the absence of the date to which the evidence and therefore the conclusion relate. One would have supposed that the average outlook of budget investigators would be in process of rapid improvement, if only from the influence of the writings of Professor Zimmerman. Of the budget studies utilized in the report under discussion over two-thirds were published subsequent to those included in the Williams-Zimmerman annotated list. Of course if the date does not matter, i.e. if the outlook of the average outlook of the budget investigators is hopeless, blame for its continuance is unwarranted. "The reason is due in part to official reports such as this." This generalization and assessment of blame immediately raises the questions, what official reports are the basis of this inference? And what evidence is there that any official reports are a cause of the average budget investigator's outlook being "not up to that of the Political Arithmetician?" Or perhaps the reviewer means that the absence of official reports of a superior type as conceived in the reviewer's imagination is the cause of the said average outlook? What is there to connect the present document with such real or imaginary reports? If I might venture to help the reviewer to clarify his thought, he seems to wish to say that he thinks I have missed an opportunity to educate the budget investigator. But to educate the budget investigator is the function of the professors; my task was the more modest one of furnishing a manual of methods to aid in making family living studies.

In short, in order to form a fair judgment of the report in relation to its purpose, the reader must evidently turn to the report itself.

In conclusion, the excellent *Studies of Family Living in the United States and Other Countries* by Faith M. Williams and Carle C. Zimmerman was consulted and utilized in the preparation of the report; reference to it was inadvertently omitted and will appear in future editions.

ROBERT M. WOODBURY

International Labour Office
Montreal

Rejoinder

My review which had to be limited to a very few words tried to say shortly what I had already said in *Consumption and Standards of Living* (New York,

1936, p. 475 *et passim*) and in two other books I have written on the subject, namely, *Family and Society* (with M. E. Frampton) New York, 1935, and *Studies of Family Living*, U.S.D.A. Misc. Publ. #223, 1935 (with F. M. Williams). In these previous analyses I have repeatedly stressed the crying need for a virile development of budget investigations, not particularly in quantity but especially in quality and in the application of *meaning* to the study of conceptions tied about the standard of living. If my terseness is interpreted as "contempt for budget investigators," it is only self-criticism or misinterpretation.

If this report is to guide investigations in other countries we may well ask what countries. Certainly the Russians, the Germanic region in Central Europe, the Scandinavian countries, the Chinese, the Japanese, the Indians and many other sections of the British Empire have already demonstrated by their several hundreds of careful budget investigations that they are acquainted with, and even beyond the methodological principles laid down in this report. If this report is to stimulate budget investigations where they are not already quantitatively well-developed, it should be printed in Spanish or Portuguese for certain of the Latin American countries, or in the native languages for some sections of Africa.

If, on the other hand, this report is to be used in the countries which have already produced budget investigation in great detail, it should, in the opinion of the reviewer, make a number of forward steps not particularly stressed in the document as it is. The problem of double entry accounting mentioned passingly here on pages 41–42 should be given more attention. If this is done, the question of outgo for future consumption should be given a definite place in the study ranking it with the same importance and dignity as consumption and non-consumption outgo. Further the whole question of income in kind and of the handling of problems of peasants and part time farmers, most prevalent groups outside of England and northeastern United States of America, should be given a broad and systematic value treatment.

My criticism of artificial limitations upon budget investigations stressed in this report by the use of the "year of average prosperity" phrase should not be thrown lightly aside. Investigators have at various times limited themselves to those renting homes in order to find out how much is paid for rent. In this particular case, the majority of the workers owned their homes. Another series of investigators limited themselves to "normal" families which were so defined that a large part of the industrial population then could not qualify for the investigation. Another particularly serious case was the picking of families fully employed earning at least $1000 a year in a period when a large proportion of the working population in that country was unemployed and (or) earning less than $1000 a year. As a result the conclusions do not apply to the given country or the given time but only to a somewhat unclear nominalistic segment of the population under investigation.

Whatever I said in the review, even if erroneous, was a thoughtful conviction based upon many years of analysis of the problem. The approach by

the Political Arithmeticians may be illustrated by the works of Sir William Petty. In my opinion these early studies stood out because the authors took the problem of the standard of living of the people and tried to probe it without any artificial limitations. Budget investigations have several centuries of history behind them. If now an official report, like this one, does not bring in the most advanced techniques and keep the analysis to a meaningful level such investigations can and have tended to become compilations of data having no inner organic meaning.

CARLE C. ZIMMERMAN

Harvard University

Reply to the Rejoinder

The reviewer now suggests that "the problem of double entry accounting mentioned passingly here on pages 41–42 should be given more attention." It is given more attention in and indeed forms the basis for the structure of sections 4 and 5 of Chapter IV. "The question of outgo for future consumption should be given a definite place in the study . . . " This subject, i.e. savings laid by for the future, is discussed under the heading "Other disbursements," pp. 70–71. The topic of income in kind is treated in conjunction with each of the specific sources of income where it is a factor, pp. 54–59, though it is of relatively little importance in studies of family living except among farmers and agricultural workers. The whole series of problems connected with family living studies among farmers and farm laborers is specifically excluded from the scope of the report, as stated on p. 5.

The rest of Professor Zimmerman's remarks seem irrelevant except as they throw light upon the reviewer's mental attitude. One may well be puzzled at the contradiction between the opinion now expressed that "the Russians, the Germanic region in Central Europe, the Scandinavian countries, the Chinese, the Japanese, the Indians and many other sections of the British Empire have already demonstrated by their several hundreds of careful budget investigations that they are acquainted with, and even beyond [sic] the methodological principles laid down in this report," and the opinion expressed in the review that "the average outlook of the budget investigator is not up to that of the Political Arithmeticians." (I interpreted the latter statement as contempt for the budget investigator.) The latter is doubtless one of the "thoughtful convictions based upon many years of analysis of the problem." The same can scarcely be said for the former since it includes a reference to the report under review, and, judging by the above examples, it does not appear that the reviewer is yet sufficiently familiar with the report to know what it contains.

Editions in French and Spanish are in preparation.

ROBERT M. WOODBURY

International Labour Office
Montreal

BOOK REVIEWS

GLENN E. MCLAUGHLIN
Review Editor

Canadians In and Out of Work, by Leonard C. Marsh. Montreal, Canada: McGill University. Social Research Series No. 9. 1940. xx, 503 pp. $3.50.

This book certainly lives up to its sub-title; it is perhaps the most concise and precise "survey of economic classes and their relation to the labour market" that has been made for any country. The distribution of the population among occupational and income grades, the regional and racial differentials, occupational mobility and access to educational facilities, the effects of boom and depression on the occupational structure, and the incidence of unemployment and relief are all set forth in statistical tables and figures easy to grasp. An outstanding success in conveying the information required is scored by the figures (22) showing the passage from school to work of young persons between the ages of 5 and 24, by the figures (20, a, b) showing the age-characteristics of occupational grades and the results of promotion, and by the table (35) showing the periods spent at school by persons in different occupational grades.

The facts thus accurately and succinctly measured are discussed intelligently and with a wide understanding of their relationships. The author even makes so bold as to tackle the problem of social stratification. What he says shows knowledge and insight, but the attempt to find (pp. 389–396) the "relative weight" of social classes, particularly the middle class, through existing statistics of occupation is a super-human task. The relative thickness and impermeability of social strata might be discovered in sample communities (typical of a country) by intensive field-work but not in my view by the use of necessarily somewhat superficial census data.

The functional as against the social grading of occupations is, on the other hand, most carefully considered—more carefully, indeed, than is usual either in the United States or in Britain. Managers are classed with proprietors; but "responsible" are distinguished from skilled workers, and intermediate classes of industrial workers and service occupations are inserted. There is, however, no attempt to classify by industry, so that it is not possible to measure how far the various economic activities entail a different occupational structure.

The author is not afraid of international comparisons and shows himself well versed in British, American, and Canadian sources. If the definitions are really comparable, it is important to note (Fig. 4 Table 11) the seemingly greater reliance placed on skilled workers in British industry; but on professional and managerial grades in the newer countries. Similarities also are brought out, particularly in the recruiting of leaders, which is so vital to successful democracies. In America as well as England there is a large waste (p. 416) "incurred by (the) misdirection of our intellectual resources." Chil-

dren who might profit by higher education often do not get it, while many who are not likely to profit do get it. The actual rulers of Anglo-Saxon democracy are also subjected to analysis by an occupational classification (Table 69) of Canadian legislators. The preponderance of lawyers over all other occupations is as apparent in Canada as in Britain and the United States.

The author's "social arithmetic" clearly calculates to some purpose and the final chapter discusses some implications of the statistical findings on public policy particularly the policy of coordinating education and working life, and of reducing the class differentials which the author's statistics have presented so ably.

P. SARGANT FLORENCE

University of Birmingham, England

Government and the Needy, A Study of Public Assistance in New Jersey, by Paul Tutt Stafford. Princeton, New Jersey: Princeton University Press. 1941. xiv, 328 pp. $3.00.

Professor Stafford's study of the relief problem in New Jersey is clearly a contribution to the fields of political science and public administration. The major part of the book contains a detailed and carefully documented account of the governmental administration of relief in New Jersey from colonial times to the present. The problems of administration and public policy, the development of relief functions in the Federal, state, and local governments are emphasized throughout. The author deplores the present confusion in relief organization resulting from the division of authority, frequently illogical and unclear, between various government agencies, and the lack of a consistent public policy for handling relief. The situation in New Jersey, analyzed in the light of its historical background and present development, is offered as a case study of a problem of national importance.

The story is a familiar one and could probably be duplicated in broad outline in many other states. The old poor law tradition, under which relief was a minor function of local government and which made little provision for any but the unfit and desperate, broke down in the early 'thirties under the impact of severe unemployment. Local relief agencies found themselves unable to cope with the large numbers of able-bodied unemployed who came to them for assistance. The state stepped in, earlier in New Jersey than in some other states, and then the Federal government. The story is familiar, but the detailed record is not easy to secure. Professor Stafford has filled in the outline with careful research, so that the intricacies of administrative relationships, statistical data on relief expenditures, costs, sources of revenue, case load, and other relevant facts are revealed in orderly fashion for New Jersey.

The first and last chapters deal with the relief problem in broader terms, giving the social and economic background and a program for reform. Professor Stafford believes that relief has become a permanent function of government and should be recognized as such, with a coordinated plan for han-

dling it at the various governmental levels. He disagrees with the emphasis of the Federal government on the temporary character of the work relief program, on the grounds that our economy has reached a declining phase and that unemployment will probably be permanent from now on. There is not space to argue this view here, except to remark that the decline of the extensive frontier need not mean that intensive frontiers will not be developed.

Few will disagree, however, that unemployment is one of our most important problems, that its relief will be necessary in some fashion for some time to come, and that its administration should be in government hands. Professor Stafford advocates Federal, state and local participation, under a grant-in-aid system from the Federal government. Direct administration would be carried on by state and local governments under standards set up by the Federal government. The success of the grant-in-aid system under the FERA will be questioned by many, yet in the field of categorical relief, Professor Stafford believes that it has been effective.

Social scientists in general will find this book useful as a reference for facts on relief administration, as exemplified by the New Jersey experience. To administrators and political scientists it will undoubtedly be of more general interest.

Elizabeth W. Gilboy

Committee on Research in the Social Sciences
Harvard University

Foundations of American Population Policy, by Frank Lorimer, Ellen Winston, and Louise K. Kiser. New York: Harper & Brothers. 1940. xiii, 178 pp. $2.50.

The principles enunciated in this work represent the views of the committee on population studies of the National Economic and Social Planning Association. The authors describe present and prospective American population trends and examine the probable implications of these trends for resource and labor problems, for the pattern of consumption, and for the level of investment and employment. Attention is given to the changing character of the family and of its rôle in American life, and to the relations between health, education, and recreation, on the one hand, and population change, on the other. In a final chapter principles of national policy are considered. The book is well organized and clearly written, and will prove useful to all who seek a compact picture of American population problems.

While much of the material is similar to that embodied in the reports of the National Resources Committee on demography and related problems, there is also a discussion of the Hansen-Keynes thesis that present demographic trends will almost necessarily entail a falling off in the level of investment and a consequent increase in unemployment. This thesis (present in the guise of a destroyer of the system of free enterprise) is not examined critically. While the relationship presupposed does exist in varying measure,

the actual nature of the relationship is far more complicated, in economic and sociological terms than the discussion suggests. For the present, dive bombers appear to be doing more than unimplemented analysis to dissipate this worry.

In the closing chapter the authors emphasize the need for a national population policy. They believe that while it is not possible to step up the rate of increase, even though it were desirable to do so, it may be possible to check the decline in net reproduction and stabilize the population at some level. A positive program is necessary, they indicate, in order that: (a) the economy can be adjusted to cessation of population growth; (b) steps may be taken to insure the replacement of the population; (c) present dysgenic tendencies may be checked; (d) a better distribution of the population in relation to economic opportunity may be effected.

J. J. SPENGLER

Duke University

The Scholarship of Junior Professional Appointees in the Government Service, by Lewis B. Sims. President's Committee on Civil Service Improvement. 1940. xxi, 228 pp.

Ever since the Federal government began recruiting young college graduates for the junior professional services, students of public service personnel have been wondering just what sort of material has been attracted. The policy of appointing young persons who allegedly have a superior general capacity, and who are to be assigned to suitable employment after they have been "shaken down," instead of trying to fill specific positions with persons possessing relevant but narrow competence, is a satisfactory procedure if the material supplied by the colleges is really superior.

Mr. Sims' statistical study of those appointed to junior professional positions carrying a salary of $2000 or more, from January 1935 to March 1939, answers part of this question. He tells us what the colleges think of the scholastic performance of the group. One of his tables summarizes his findings:

Scholastic Standing of Junior Professional Appointees, from January 1935 to March 1939

Fifth of Graduating Class	Percentage of Totals			Number
	Recruited through Civil Service Commission	Recruited Otherwise	Combined Recruitment	
1st	35	23	29	1256
2nd	26	24	25	1082
3rd	16	21	19	829
4th	13	17	15	658
5th	10	15	12	542

These figures are not reassuring. The 5190 appointees, most of whom are classified above, came from 130 different schools, in many of which scholastic standards are none too high, and yet 46 per cent are from the lowest three-fifths of their graduating classes. The President's Committee on Civil Service Improvement has a job to do, to persuade professors, deans, and college vocational advisors to hold up the public service as a career fit for the best. The state-supported schools are apparently less remiss in this respect: The University of California (at Berkeley), the University of Minnesota, Iowa State College, the University of Illinois, and the Pennsylvania State College furnished 727 of these young people, while Harvard, Columbia, Pennsylvania, Yale, and Princeton provided only 192, little more than a fourth as many. (This is not entirely explained by the disproportionately heavy recruitment in the Department of Agriculture.)

Mr. Sims' compilation was a painstaking one and includes hundreds of tables and breakdowns, by schools, services, and departments, but since it was confined to scholastic grades from non-comparable institutions, its usefulness is extremely limited. We shall be looking for more pertinent studies from the committee, touching among other things on capacity, adaptability, enthusiasm, and promotion.

James C. Charlesworth

University of Pennsylvania

Talents and Tasks, Their Conjunction in a Democracy for Wholesome Living and National Defense, by Truman L. Kelley. Harvard Education Papers No. 1. Cambridge, Massachusetts: Harvard University Graduate School of Education. 1940. 48 pp.

In the first few pages of this pamphlet we find an impassioned plea—almost a crusade—for democracy and a strong denunciation of totalitarian government. A broad national objective is proposed which is concerned with the problem " . . . so to utilize the talents of our differentially endowed and trained citizens as to maximize their satisfactions and their social productivity." It is proposed that this social objective be attained by a statistical analysis of variables for which computational steps are given in detail.

A rather ambitious program is outlined and although it is undoubtedly pointed in the right direction, considerable difficulty, much of it non-mathematical, would be encountered in making the proposal effective. It would require a much more thorough analysis of tasks and even of society itself, than we now possess. Abstractions such as "social utility," "individual well-being," "needs of the nation," "social usefulness," and "human problems of welfare" sound attractive until we try to translate them into specifics. Who will determine "needs?" Who will create jobs for certain talents? Will we permit innocuous but perhaps personally satisfying types of work? Interests do not always correlate with talent—what to do in a democratic society if a youth still *wants* to do that which he ought not to try to do? Perhaps true

democracy involves the right to fail! Society is a dynamic structure in which social utility may change rapidly particularly in times of crisis; by way of example, we need only call attention to the sudden and high importance which tool-makers have recently achieved.

One is inclined to feel that resolving techniques (statistical procedures) have now outstripped accumulative techniques (valid tests). Certain areas such as character and temperament are inadequately sounded at present; even intelligence, as extensively and intensively as it has been worked on, seems now to be breaking down into a number of identifiable factors. Nevertheless, in spite of deficiencies and the need for caution, it seems probable that social placement attempts are going to be made. Certainly these efforts at conjunction of talents and tasks should follow the latest scientific developments, and we have here a contribution toward that end.

MARTIN F. FRITZ

Iowa State College

Old-Age and Survivors Insurance Statistics, Employment and Wages of Covered Workers, 1938. Washington: The Social Security Board. 1940. xxiii, 268 pp.

The federal old-age insurance program established by the Social Security Act in 1935 and amended in 1939 provides for old-age and survivors benefits related to wages earned by individuals in covered employment, and thus requires vast bookkeeping. Each dollar of wages (up to $3,000 during a calendar year) paid in covered industries must be reported by employers to the Treasury, then by this Department to the Accounting Operations Division of the Bureau of Old Age and Survivors Insurance of the Social Security Board, and credited to the account of the respective wage earner. Nearly 50 million individual accounts continuously carried by the Board constitute a current record of earnings of the majority of the working population of the Nation.

With the extension of the program to the occupational groups now excluded—such as employees of non-profit organizations, agricultural labor, domestic servants, and self-employed—this record will become a Nation-wide accounting of earnings and incomes. The combination of inclusive earning statistics with personal characteristics of the earners makes possible cross-classifications of all kinds. Wage statistics based on voluntary reports of selected firms not necessarily typical of industry as a whole have become obsolete. Trustworthy bench marks are provided for checking current employment statistics and estimates of the flow of national income. These all are reasons enough for statisticians to watch the social security statistics grow!

With the issue of this book, selected statistics derived as a by-product of the operation of the Bureau of Old-Age and Survivors Insurance are now released for public use. More than 26 billion dollars of taxable wages earned in 1938 by approximately 31 million individuals are classified here by wage intervals, sex and age of earners, number of calendar quarters with wage

credits, state, and industry. For 13 states special tables for Negro and non-Negro workers have been prepared. The emphasis is on two problems: continuity of covered employment and differentials in structure of earnings by industrial divisions.

To the 1938 tabulations which constitute the bulk of the volume are added tables for the year 1937 which stress mainly state differentials in wages and interstate migration of covered workers.

Methodological limitations of the new tabulations, their place in the system of American statistics, questions which they are likely to clarify, and new problems which arise, cannot be discussed in this brief note. The reviewed publication opens a new page in the history of American statistics and is recommended to the particular attention of students in labor economics.

W. S. Woytinsky

Committee on Social Security of the
Social Science Research Council

Methods of Assessing the Physical Fitness of Children, by Rachel M. Jenss and Susan P. Souther. Washington, D. C.: Children's Bureau Publication No. 263. 1940. vi, 121 pp. 15 cents.

In any program for improving the physical condition of children an important factor is a practicable procedure to indicate those children who are most in need of attention. In an attempt to develop an easily applied method of assessing physical fitness, various indexes of body build have been devised, based on the relation of weight or girth of arm to age and height or to age, height, and some lateral measurement. This study is an evaluation of four of these indexes: The Baldwin-Wood Tables, the A C H Index, the Nutritional Status Indexes and the Pryor Width-Weight Tables. It is based on observations made on 713 seven year old school children of New Haven, Connecticut.

The criteria used in evaluating the four indexes were based on a clinical judgment of poor or very poor nutritional condition made by a pediatrician, on a low rate of growth in weight or girth of arm or on a combination of the two elements. All the indexes were found to lack both sensitivity and specificity: that is, many of the children whose condition was indicated by the criteria as unsatisfactory were not picked out by the index and conversely many of the children whose condition was indicated by the criteria as satisfactory were picked out by the index as unsatisfactory. There was also considerable disagreement in the clinical judgments of different pediatricians.

John R. Miner

Mayo Clinic

Controlled Fertility, An Evaluation of Clinic Service, by Regine K. Stix and Frank W. Notestein. Baltimore: The Williams & Wilkins Company. 1940. xiv, 201 pp. $3.00.

Because the field is a focus of study for persons trained in a number of traditional disciplines, population problems are being subjected to a convergence of varied approaches and research techniques. In this advancing field *Controlled Fertility*, by authors with different types of training, provides a model of monographic excellence both with respect to method and with respect to importance of findings.

A listing of the methodological virtues of the study reads like an outline of tenets advised in every course in methods of research, but seldom heeded so meticulously. First in evidence is careful design of the study to secure the desired information; next, the gathering of data by an expert (Dr. Stix); next, the thorough statistical analysis of data with well constructed tables and graphic forms for presentation of results; next, interpretation of the results both in reference to the specific inquiry and in reference to their broader implications; and finally, especially pleasing to the statistician, appendices which explain procedures so precisely that anyone could follow them and compute from similar data comparable pregnancy rates or ratios of effectiveness of contraceptive techniques.

The most important specific finding of the study is that major attention should be given to the *acceptability* of contraceptive methods rather than to the *potential effectiveness* of methods when correctly used. The implication of this finding is that more flexible clinic policies and programs are needed. Other interesting findings are suggestive evidence that there has been no decline in biological fecundity since 1890; that there is no lessening of fecundity caused by the use of contraceptives; that the great decline in the birth rate has been effected by the increase in use of folkway methods of contraception; and that birth control clinics have played a relatively minor rôle in disseminating contraceptive information in the United States.

In keeping with the broadening concept of the content of population programs, the authors use their evidence to point to the necessity of other features than birth control in a realistic population policy. They believe that the will to reduce fertility among the depressed groups of our population will come only in response to broad changes in living conditions; that birth control has small chance for success as an isolated movement, but instead should be an indispensable part of an integrated crusade for better living.

MARGARET JARMAN HAGOOD

University of North Carolina

Population, Births, Notifiable Diseases, and Deaths, assembled for New York City, N. Y.: 1866–1938—Planned by Haven Emerson, M.D., and executed by Harriet E. Hughes. New York: The DeLamar Institute of Public Health, College of Physicians and Surgeons, Columbia University. January, 1941.

One cannot help but be impressed by the mass of data contained within the pages of this volume of tabulations. All but 12 of the 406 pages of the com-

piled vital statistics data for New York City are devoted to morbidity and mortality tabulations covering a 72 year period. Morbidity (for notifiable diseases only) and mortality data for each cause of death are presented in three basic tabulations—namely, cases of diseases reported by week, deaths reported by week, and deaths by age and sex for the years that data have been available during the period, 1866 to 1938.

According to the authors, there is no other source of "authentic information for the vital statistics of New York City from 1866 to 1938." This report therefore represents a unique contribution from that point of view. The tabulations are of unquestionable value for some purposes but other considerations make it difficult to make an appraisal of the data as a reference source. Perhaps the most serious of these considerations is the use of the 1929 International List of Causes of Death in presenting statistical data for the entire 72 year period. Although the authors state that certain adjustments were made in an attempt to maintain statistical comparability through the various decennial revisions of the International List, it is obviously impossible in many cases to preserve comparability when separate titles are used. There is, however, no evidence to indicate that the closest practical approach to comparability was not achieved, but it is unfortunate that the authors did not discuss fully the manner and method in which the tabulations were made in order to make the data as comparable as possible.

Data were obtained from over 100 different reports in the preparation of this volume. While it is admittedly impractical to indicate the source of each figure in the volume, some reference should be made to the original reports from which the data were compiled.

In the introductory remarks, the authors point out the incompleteness of morbidity reporting. They also explain some of the reasons for certain discrepancies between the weekly number of cases of disease and the weekly number of deaths reported for the corresponding disease and state that, "Errors of diagnosis, delay in reporting, and other factors involved in current records by weeks or months of the communicable diseases are responsible for the slight differences in the number of deaths ascribed to the disease on the two sets of sheets." No specific mention, however, is made of an equally important cause, the fact that the two sets of weekly data do not necessarily refer to the same population since there is generally a variable period of lag between the time when a case is reported and when death ensues. This and the other limitations already mentioned make it impossible to calculate case-fatality rates on a weekly basis as one first hopefully supposes in finding the weekly morbidity and mortality data arranged side by side.

In summary, it may be said that this report represents a worthy effort to bring together in one volume certain tabulations relating to population, birth, morbidity and mortality data. The compilation is not without its defects, but these might be partially overcome by a more thorough evaluation of the data. It is not possible to present adequately vital data covering a long time period, without qualifying in detail the gaps which are inevitably

present. It is to be hoped that the authors in some future publication will present a discussion of the manner in which the data were compiled, their source, and limitations. If this were done and published, perhaps as an appendix, the present volume would assume greater value.

HALBERT L. DUNN

U. S. Bureau of the Census

Statistical Methods for Medical and Biological Students, by Gunnar Dahlberg. New York: Interscience Publishers, Inc. 1940. 232 pp. $2.75.

In his preface and introduction, the author mentions the increasing use and appreciation of statistical methods in the medical and biological sciences. The desirability of extending the application of statistical methods is emphasized. The book is presented as an elementary, non-mathematical exposition of statistical procedures to assist in furthering this much to be desired objective.

A perusal of this textbook will not lead most medical students in this country to classify it as non-mathematical. It contains much in the way of elementary algebra and mathematical logic that will require on the part of the beginning student careful attention and considerable determination if they are to be mastered.

It would hardly be possible to reduce further the mathematics included and give much of an idea of the bases of statistical procedures. The author's "compromise between the demands of the mathematical statistician and the mathematical limitations of the medical and biological student" compares well with the many attempts made to solve this problem as illustrated by the numerous elementary textbooks on statistics that have appeared in recent years.

The first three chapters deal with probability, combinations, and the binomial theorem. Next come chapters dealing with methods of handling quantitative data, including the calculation of averages, the measurement of variation, the comparison of samples, and the evaluation of correlation as applied, in the main, to large samples. In discussing correlation, the tetrachoric coefficient of correlation is briefly described, a somewhat unusual selection for an elementary book.

The methods of analyzing qualitative data and of determining the goodness of fit are discussed, though additional practical applications of the chi-square test might well have been included. Space is not devoted to such subjects as rates, life tables and their construction, registration methods, and population problems generally classified under vital statistics.

The book is clearly written in an interesting style, and the illustrative data used should be of interest to medical and biological students.

GAIUS E. HARMON, M D.

Detroit Department of Health

Statistical Methods Applied to Experiments in Agriculture and Biology, by George W. Snedecor. Ames, Iowa: Iowa State College Press. Third Edition. 1940. xiii, 422 pp. $3.75.

Since the first editions of this book have been extensively reviewed, it is not necessary to deal with the main body of the text. In the third edition, several additions have been made that are of considerable value. Two short sections have been added to the chapter on linear regression. These are entitled, "Regression and rates," and "The standard error of a forecast." The title of the latter section may be misleading to some in that the section actually deals with standard errors of values that have been adjusted by linear regression equations. In many cases this is not strictly a matter of forecasting. It is unfortunate that there are mistakes in the formulas of this section. On line 8 of page 122, Sx^2 has been omitted as the divisor of $(\bar{x}_k - \bar{x})V_{y \cdot x}$, and in four places on the same page minus signs should be plus signs.

The re-written section on "Test of homogeneity of variance in several groups" is extremely useful, as this is becoming a standard procedure in many projects requiring statistical analysis. Another new section has to do with transformations of data for tests of significance. This is also very timely as there is undoubtedly a good deal of confusion as to the need for transformations and how they should be made. The explanations are clear and logical and the necessary tables are given.

The chief addition to the book is an entirely new chapter "Design and Analysis of Sampling." This is a subject which is not dealt with in most books on statistical analysis and there seems to have been an impression that modern statistical methods, as exemplified chiefly by the analysis of variance technique, do not have a direct bearing on sampling problems. Snedecor illustrates how the principles of the analysis of variance throw a great deal of light on problems of this type. This chapter is excellent; the only suggestion that might be made is that stricter editing of the first few pages would have contributed to greater clarity of statement.

C. H. Goulden

Dominion Rust Research Laboratory
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Statistica Economica con Riferimenti alla Organizzazione e alle Fonti, by Giovanni Lasorsa. Cedam: Casa Editrice Dott. Antonio Milani. Padova: 1940. vii, 405 pp. 63 lire.

This textbook has apparently the following objectives: 1) to list and describe the principal official sources of data about the economic resources and activities of Italy and other countries; 2) to consider critically the validity and comparability of data collected in different countries; and 3) to outline some very elementary techniques of statistical elaboration of the data. These

objectives are sufficiently well realized in the exposition of the subject matter which is segregated under two main headings: census of economic enterprises and statistics of economic activities. The first part is concerned with the methods employed in surveys of agriculture and industry. The census forms devised by the International Institute of Statistics are presented in detail together with the modifications introduced in certain countries. The results of the census taken about 1930 in 21 countries are compared relative to land in use, and livestock. With reference to industry, the discussion centers principally on the methods and results of the Italian censuses of 1927 and 1937–39. Some comparisons of a very general nature are made with the recent findings reported in other countries. The second part of this work is devoted to the measures of fluctuations and trends in stocks of goods, money, prices, consumption, and international commerce. In this section much emphasis is given to the need for careful scrutiny of the reported data because of the well-known inconsistencies manifest in the techniques of collecting such information. The author evaluates clearly the merits of several procedures to render more meaningful the available data and comparisons between countries. To this end, reports and studies published under the auspices of the League of Nations or of the International Institute of Statistics are reviewed. The findings discussed are familiar to most students of economics but some tabulations particularly those relating to the food supplies of Italy deserve to be given greater attention in view of the present international conditions. Lasorsa's figures bring out that from 1922 to 1937 Italy succeeded in reducing its food requirements from foreign countries, and that while the situation with reference to supplies of carbohydrates and protein was in 1937 not unfavorable the need for foreign fats has continued to be the weakest point in Italian economy.

Although the author's attention is focussed mainly on the status of Italian statistics, he has also taken into account the progress of ideas on the subject in other countries. Within its limits as an elementary treatment of the initial aspects of statistical technique this textbook is of the first order. It does not include, however, a bibliography.

ANTONIO CIOCCO

National Institute of Health

Punched Card Methods in Scientific Computation, by W. J. Eckert. New York: The Thomas J. Watson Astronomical Computing Bureau, Columbia University. 1940. ix, 136 pp.

A long-felt need for an exposition of the statistical (as opposed to the accounting) possibilities of punched card equipment is partially satisfied by this able, somewhat specialized monograph. Dr. Eckert, now Director of the U. S. Nautical Almanac Office, at the time of writing represented Columbia University's Astronomy Department and Rutherfurd Observatory on the Watson Bureau, which is jointly sponsored by the American Astronomical

Society, the International Business Machines Corporation (whose president is Thomas J. Watson), and Columbia University. Inevitably, the non-astronomically inclined (including the reviewer) will find some translation necessary in applying these methods to their own research; nevertheless this monograph contains the best statement of the basic operating principles of the Hollerith punched card method, and the best summary of available equipment and of the tasks it is designed to perform, of which the reviewer is aware.

The general reader will find especially helpful the suggestions for short cuts and more efficient use of various pieces of equipment, special sorting techniques, and the careful exposition of the method of progressive digiting (whereby product sums may be obtained quickly and inexpensively from sorter and tabulator, if the individual products are not required). Also of general interest are: the construction of card files which constitute tables of tabular functions, the use of the multiplying punch to perform LaGrangian interpolation and of the tabulator to accomplish interpolation by differences, the multiplication of series, harmonic analysis, and numerical integration. The chapters entitled "The Calculations Involved in the Construction of Catalogue of Photographic Star Positions," "Stellar Photometry," "Numerical Lunar Theory," and "The Computation of Planetary Perturbations," are likely to prove somewhat esoteric, however.

The description of the various punched card machines and their plugboards is good, though brief, and is sufficiently modern to include the Collator. The Bureau is evidently not equipped with an alphabetic tabulator, but this is not surprising in view of the special nature of its work. For those workers who require the greater versatility of the alphabetic as opposed to the numeric tabulator, the slight mention of the former will be a disappointment. Because of the similarity of the two machines in principle, this is not, however, a major omission. In the reviewer's opinion this is a "must" book for any statistical bureau using Hollerith equipment in scientific work.

Francis McIntyre

Indiana University

Graphs, How To Make and Use Them, by Herbert Arkin and Raymond R. Colton. New York: Harper & Brothers. Revised Edition. 1940. xvi, 236 pp. $3.00.

The 1936 edition of this book was reviewed in the September, 1936, issue of this Journal. The changes in the new edition are minor and relatively unimportant. A five-page chapter on graphic layout is added to improve the continuity of the early part of the book. A few new charts are included, but the numbering has not been disturbed since these are assigned numbers 7a, 38a, etc. Although the changes made are generally in the direction of improvement, in places the facing page has been shifted so that the discussed charts are inconveniently placed (notably see pp. 55–56).

This book fills a distinct niche in the statistical literature. It is simply written and covers as wide a range of topics as any person other than the expert is likely to find of interest. The emphasis is on chart construction and from the point of view of elementary practice it has no equal in this respect. The intended character of the book is such that the reasons for using procedures are included only if they can be stated simply. Therefore, parts of the book are less thorough than the chart discussion in elementary textbooks on statistical method.

Several accomplishments may properly be expected from a book on graphs —notably, illustrations of types and explanation of their uses, comparative advantages of different types, the best methods of construction, recognition of illusion, and presentation standards. The book in review scarcely touches on the illusion problem. On standards the 1915 codification is appealed to, and no reference is made to the important work of recent years done by the American Society of Mechanical Engineers, the American Society for Testing Materials, and the American Standards Association. The comparative advantages of different charting methods are given too little consideration.

ELMER C. BRATT

Lehigh University

Building Cycles and the Theory of Investment, by Clarence D. Long, Jr. Princeton, New Jersey: Princeton University Press. 1940. xvi, 239 pp. $2.50.

The current importance of studying the great cycles of business activity which seem to characterize certain industries is widely recognized, but those who have attempted such studies have found great difficulty in bringing the necessary materials together. This book will be welcomed by students of cycles as a real contribution to the literature on the subject. As the basis of his study Dr. Long has made an exhaustive search of the literature of the field, and he has presented the outstanding points in summary form in this volume. He has also made new compilations of data from original sources and he represents three sets of long-term building data, namely: Annual indexes of value of five classifications of building, 1868–1935; annual indexes of number of three classifications of building, 1856–1935; and a monthly index of building, 1868–1940. The theory of investment is handled as a development of the investment-consumption interaction, with attention to many factors, including elasticity of demand for houses, the growth of speculation, the increase in the use of mortgage credit, and the association of cycles in building and stock prices.

Numerous instances of conflicting opinions or doubtful conclusions are cited and both sides of the questions are analyzed. The treatment of the many questions is such that the reader should be encouraged or inspired to undertake further study. The paragraphs, for example, on "The Lag of Building Recovery," "The Lead of Building in Depressions," and "Why

Cycles in Building are Long," suggest many fields for worthwhile investigation. The difficulties regarding statistics, particularly those of costs, are pointed out, and the author is careful to indicate that he does not expect too much from his statistics. For the economist and for the practical business man, who wish a summary of the work that has been done with new material expanding the work and bringing it up to date, together with well applied straightforward analyses of the factors involved, this book will serve a long felt need.

John R. Riggleman

General Land Office
U. S. Department of the Interior

Great Britain under Protection, by Frederic Benham. New York: The Macmillan Company. 1941. xvi, 271 pp. $2.50.

Dr. Benham's book is one of a series which is planned to cover the recent tariff history of the principal European countries. The series is sponsored by the Carnegie Endowment for International Peace and is edited by Dr. Florinsky. As judged by this first volume, students of international trade and finance policy should find the series to be a helpful source of information.

The book deals mostly with events since 1931. According to the author, Great Britain became definitely protectionist with the Import Duties Act of 1932. The shift in British policy from free trade to protection is presented in the first chapter as a rather sudden change precipitated by the world-wide depression. The analysis, however, of the British tariff and other forms of protection in the next two chapters indicates that several significant changes occurred prior to that date; namely, the McKenna Duties of 1915, the Dyestuffs Act of 1920, the Key Industry Duties of 1921, the Sugar Subsidy of 1924, etc. These changes were primarily connected with national defense—a factor which the author fails to discuss in chapter one.

A short discussion of British tariff-making provides an interesting contrast with American practice. Changes in the tariff are made mainly by the Import Duties Advisory Committee. The account of imperial preference and the British trade agreements establishes several important points; namely, the limited possibilities of confining trade within the Empire, the British insistence on most-favored-nation rights which prevented the formation of low tariff unions among various countries, and the signature in 1938 of the Anglo-American trade agreement which indicated a turn towards a more liberal trade policy. Protection with regard to the iron and steel industry and agriculture is analyzed in detail in chapters VII and VIII. The other three chapters are devoted to monetary policy, economic recovery, and to concluding statements. A useful statistical appendix is included.

The author concludes that British trade and exchange policy improved temporarily the export situation, that the tariff assisted British economic recovery, and that "the main cause of the recovery was perhaps the low

prices of imported foodstuffs" (p. 247). This analysis of British recovery, especially of the rôle of monetary policy, does not seem adequate to the reviewer. It certainly is not improved by the unsupported comments of the author with regard to dollar devaluation (p. 161) and by the immoderate repetition of these comments by the editor.

CLIFFORD L. JAMES

Ohio State University

Maps of Selected Industries Reported at the Census of Manufactures, 1937. Washington: U. S. Bureau of the Census. 126 pp. $1.00.

This is a folio containing 117 maps for selected leading manufacturing industries, notably those of particular importance to the national defense program. The mapping of the selected industries resulted from a cooperative study by the Bureau of the Census and the Bureau of Agricultural Economics. Maps for some of the industries were prepared at the request of the Advisory Commission to the Council of National Defense.

Three maps are presented for each of 39 industries. The first map shows the distribution of the establishments in the selected industry, by counties. The second map shows the approximate number of industrial wage earners employed in the particular industry by counties, as indicated by shading or ruling for five categories. The third map shows the approximate size of the industry in terms of dollars of value added by manufacture, again for five class groups.

The limits for the wage-earner and value-added categories have been set wide enough so that information can be given for all counties in which an industry is represented without running afoul of the disclosure rule which forbids the Bureau of the Census to reveal the data of a given establishment. In spite of this rule the Bureau has been able to present figures which show for all parts of the country whether an industry is of minor, small, medium, considerable, or great importance. Such efforts will doubtlessly result in much wider use of the regional data.

There is printed at the side of each map, with a few exceptions, the name of every county for which data are indicated. The county names (listed by states) are numbered and corresponding numbers are printed beside each county area shown on the map, except for certain unintentional omissions and except for industries so widespread that such detail cannot be presented. The county numbering system is not the same on the three maps for some industries. It would have been easier to follow the set of maps in these cases to obtain the information available, if it had been possible to identify each county by the same number. In some cases two or more adjacent counties are grouped together as a single shaded or ruled area on the wage-earner or value-added maps. It is important to note in such cases that each of the counties, rather than the combined group, falls in the indicated category. This and other explanatory information on the use of the maps should have been included.

The maps in this folio are useful to show at a glance the relative concentration and dispersion of establishments in the selected industries; also to show the relative employment and production in these industries. The maps should be of especial value to those who are concerned with problems regarding the location of industries. Mr. Harold D. Kube of the Bureau of the Census and Mr. Ralph H. Danhof of the Bureau of Agricultural Economics should be congratulated for planning and developing such a useful folio of maps.

Oscar L. Endler

National Resources Planning Board

Tinrestrictie en tinprijs (*Tin restriction and tin price*), by M. J. Schut. Haarlem: De Erven F. Bohn N. V. 1940. xii, 115 pp.

Most of the quantitative studies of the laws of supply and demand of raw materials relate to agricultural products. The present study of the dynamics of the international tin market is very welcome as an extension of the methods of these studies to a mining product.

The purpose of the investigation is to provide a quantitative basis for estimating the effects of the international tin restriction scheme, which has been in operation since 1931, on the level and stability of tin prices. To that end a systematic study is made of the factors determining consumption, production, and the price of tin, using statistical series usually beginning about 1920 but in some cases going back to 1904.

The demand for tin appears to be dependent to a greater extent on the activity in the various industries in which it is used than on its price. This conclusion, already suggested by the small contribution of the cost of tin to the cost of the principal final products, is confirmed by multiple regression analysis.

The price of tin is mainly determined by the size of world tin stocks, with the rate of increase in stocks exercizing a subsidiary influence. The explanation of the influence of the volume of production, required to complete the picture, meets with considerable difficulties which are connected with differences in degree of mechanization and in reaction to prices as between the several tin production processes.

In the various statistical analyses the reader is sometimes left with a choice between two or more mutually exclusive explanations. The alternative theory explaining production essentially as carried out "on order" and therefore directly determined by demand indeed makes changes in stocks an irrelevant random variable, and is therefore incompatible with the important rôle properly assigned to fluctuations in stocks in the mechanism of the market. Similarly, in the explanation of tin consumption, a table giving the proportion of total consumption assignable to automobile and tin-plate production as less than 50 per cent is followed by a regression analysis making fluctuations in production in these two lines responsible for all fluctuations in demand other than those due to changes in price.

The discussion of the influence of the restriction scheme is very instructive in that it illustrates a type of argument which is the only recourse when the statistical basis is deficient in certain respects. One rather uncertain coefficient, the elasticity of supply, is given several tentative values in order to show that the particular conclusion drawn is valid for a wide range of values assumed by this coefficient. The conclusion is that in the absence of the restriction scheme the tin price would have remained for several years on a level unremunerative at least for the not completely mechanized producers.

TJALLING KOOPMANS

Princeton University

Wheat Studies of the Food Research Institute, Stanford University, California.
"World Wheat Survey and Outlook, September 1940," by Helen C. Farnsworth and V. P. Timoshenko. Volume XVII, Number 1. September, 1940. pp. 1–38. 75 cents.
"Wheat Subsidization and Exports, The Experience of 1938–39," by V. P. Timoshenko. Volume XVII, Number 2. October, 1940. pp. 39–110. $1.00.
"Price Relations of Liverpool Wheat Futures With Special Reference to the December–March Spread," by Sidney Hoos and Holbrook Working. Volume XVII, Number 3. November, 1940. pp. 101–144. $1.00.
"The World Wheat Situation, 1939–40, A Review of the Crop Year," by Joseph S. Davis. Volume XVII, Number 4. December, 1940. pp. 145–220. $1.25.

Two of these monographs deal with the world wheat situation during the crop year 1939–40. These annual objective studies are of great service towards the understanding of market phenomena and especially of price movements. In this particular year the large carry-over and crop, the new great war, domination by a few governmental agencies, and unpredicted changes in crop conditions both in Argentina and the United States were factors of major importance in the history of the crop year. The problem of accurate advance estimates of world supply is dramatically illustrated by both private and official data for 1940. On the average the estimates for 1933–38 changed little as the seasons advanced, but the December 1939, estimates were only two-thirds or less of actual harvests. Other marked changes in estimates are noted for 1917, 1920, and 1939. This is one important source of explanation of seasonal price fluctuations that occur in the grain markets and that I discussed before the Association meeting at Chicago in December 1940 (*Journal of Marketing*, April, 1941).

The other two monographs deal with special phases of wheat-market phenomena. Timoshenko describes and evaluates the many government interventions and the various schemes of wheat subsidization as they actually operated in 1938–39. The two previous years had shown little in the way of governmental control apparently because of short world crops, but in the year here under study practically all principal countries re-established their

controls. That competitive subsidization would have continued at high cost in 1939–40 appears likely had it not been for the European war. Some subsidization did continue, but in modified form. Timoshenko concludes that the experience with competitive export subsidization in 1938–39 gives little support for this approach to the problem of export surpluses of wheat. One is reminded, also, of Woodrow Wilson's remark in 1908: "Regulation by commission is not regulation by law, but control according to the discretion of governmental officials."

Hoos and Working present another excellent example of statistical analysis of price movements and relationships. Their study of Liverpool wheat futures supplements an earlier study of Chicago futures. The present reviewer finds, however, that in some respects this study leaves him cold. Market price in a market of this sort must be the result of decisions of buyers and sellers. At best, the moderate correlation found between certain measured supply-and-demand conditions and price relations is indirect evidence that buyers and sellers were led to their decisions by these conditions. Whether or not buyers and sellers really use these criteria could perhaps be answered more directly by the large operators themselves. Perhaps, however, the purpose of the study is to show what the authors believe "should" be considered by buyers and sellers. If that is the purpose, then the study seems to me still wider of the mark. I hope that some day students of market price can find a method of direct measurement of the things that lead individual buyers and sellers to make specific transactions. Once such information becomes available it may be possible to understand market phenomena.

ROLAND S. VAILE

University of Minnesota

Wartime Control of Prices, by Charles O. Hardy. Washington, D. C.: The Brookings Institution. 1940. x, 216 pp. $3.00.

In this study, Hardy has given us a thoughtful and lucid analysis of wartime price problems; it should be welcomed by non-technical readers as an intelligible survey of a difficult subject and by economists as an admirably balanced account of price control policies. The reviewer recalls no other book in the past decade, with the possible exception of Slichter's *Towards Stability*, which has the same combination of sound scholarship, extensive coverage, popular style, and avoidance of a doctrinaire position. Intelligent people with no background in economic analysis ask with increasing frequency for help in understanding price and fiscal problems and the proposals for government action in the area. Hardy's book seems to be an almost perfect answer to such questions.

A seventeen-page introduction, which might well be reprinted in pamphlet form for wide distribution, contains a summary of the analysis on problems in price control presented at length in Part I. Successive chapters,

in Part I, are devoted to "The Nature and Scope of the Problems," "Control of Prices through Fiscal and Banking Policies," "Indirect Control over Prices," "Selective Control of Prices," "The Machinery of Control," and "Control by Fixing a Price-Ceiling." The emphasis is on increases in incomes in excess of increases in goods as the basic factor leading to rising prices. Lack of collaboration between price control and fiscal authorities complicates any plans for control. Likewise, any control device whch ignores the inflationary force of expanding incomes will be unsatisfactory. It is on this basis that the imposition of a general price-ceiling is rejected.

Hardy prefers selective price-fixing and distinguishes between industries in proposing different control policies to meet different situations. Small government purchases of standard commodities may be made in the open market, while special work can be done only on specific contracts. When the government buys a large part of the available output of a standardized commodity, price-fixing is desirable but the price should not be set on the bulk-line principle, especially if the number of producers is small. Individual contracts with separate producers at prices based on the recent costs of each are advocated to insure efficiency and avoid large profits to low-cost concerns The bulk-line principle is recognized as useful only where the number of producers is too great to make individual contracts possible and where prices are fixed for the general public. Price-fixing for purchases by the public are considered not justifiable "unless the shortage is acute enough to necessitate or justify some type of rationing," which will have to be carried out by a direct rationing device if prices are not allowed to increase. If a free market is allowed for civilian buying, care must be taken to insure adequate deliveries to the Government. Hardy's discussion of wages in a war economy deserves wide attention at the present; he says policy should be designed to encourage absorption of labor, to permit adjustments in wages to rising prices caused by inflation but not necessarily to price increases due to restricted supplies, and to discourage any acceleration of inflation by increases in wages in excess of the general income expansion.

Part II contains an excellent survey of price policy during World War I with particular reference to basic materials, food, fuel, and rents. A reconsideration of these facts and policies gives a valuable background for current and prospective problems. The book stresses the varying conditions in different industries. This is particularly useful to forestall an unduly simplified approach.

DAN THROOP SMITH

Harvard University

The Pattern of Consumer Debt, 1935–36, A Statistical Analysis, by Blanche Bernstein. New York: National Bureau of Economic Research, 1940. xviii, 238 pp. $2.50.

This book is the sixth in a series on consumer finance. One must use great care in reading it, mulling over eternally the meaning of the terms used. The

trouble comes from the nature of the data collected. There is an old saying among small loan lenders that the time to insure good collection is at the time the loan is made. It would seem that the time to insure a good piece of statistical work is when the facts are collected, or perhaps one should say when plans are made for the collection of facts. No amount of scientific statistical manipulation (in this case it is exceedingly good) can cure errors made in these early stages.

This particular study is based on the results obtained from a "Works Progress Administration project conducted by the United States Bureau of Home Economics and the United States Bureau of Labor Statistics in cooperation with the Central Statistical Board and the National Resources Committee." How such an imposing array of talent could have planned the kind of a survey it did is frankly beyond the reviewer's understanding. In scope it was broad, including 60,000 families located in some 51 cities, 140 villages and 66 farm counties in 30 states. But "the information obtained from each family referred only to *net change* in each type of debt and not to the existence of instalment, cash loan and charge account or to the total amount of such debt." The complications which arise out of this limitation on the inquiry are so many that at times the thought has occurred to the reviewer that it might possibly have been better if the W.P.A. had stuck to raking leaves.

The author admits the difficulties but courageously tries to surmount them. She states, for example, that "to avoid continual use of the expression 'families having a net change in debt' the term 'families indebted' has been adopted as a synonym, and for similar reasons the terms 'frequency of debt' and 'extent of use of instalment (or cash loan or charge account) credit' are employed to represent the per cent of families having a net change in debt or the per cent of families indebted during the year." Then "extent of use of instalment (or cash loan or charge account) credit" really refers to the families making payment on such obligations. All these synonyms are, of course, necessitated by the nature of the data. In view of the difficulty of making clear and understandable what is vague in the original data, the reviewer has great hestitation in quoting findings that emerge from the careful study of the material which Miss Bernstein has made.

It is estimated that about one-quarter of all non-relief families had a net change in their indebtedness for instalment purchases in the year 1935–36. Ninety per cent of these had incomes of less than $3000 a year. For all non-relief families this form of credit added only 0.9 per cent to aggregate income during this period. Only 30 per cent of the families had decreased their indebtedness at the end of the year. Wage-earning families made more use of instalment credit than other non-farming groups of equivalent income. Size of family did not seem to have much effect on the use of instalment credit. Sixty per cent of the net increase was due to automobile purchases. Instalment credit was used more extensively in urban than in farm communities.

The data on cash loans do not distinguish between loans repayable in instalments and those on a straight time basis. There is the assumption that the latter are for the most part for consumer purposes. The reviewer doubts this, the more so, since, proceeding on this assumption, it is found that cash loan credit is "used more extensively by families living on farms than by those in any other type of community." Now the agencies furnishing cash loans for consumer purposes operate, with few exceptions, in cities. It would seem that here again the quality of the data needs to be viewed with suspicion.

Over 9 per cent of all the non-relief families are said to be indebted for cash loans in the period studied. Over 90 per cent of those indebted had annual incomes of less than $3000. This cash credit added 0.6 per cent to the income of the borrowers. Sixty-eight per cent increased their indebtedness.

The data on charge account indebtedness are likewise of a peculiar nature. For example, families which settled their debt on a weekly or monthly basis are not included but only those which showed a net change at end as compared with the beginning of the year. Hence, again, let the reader beware! Eleven per cent of all the non-relief families are estimated to have had a net change in charge account debt. Charge account debt is heavily concentrated among low-income families. Over 80 per cent of the families studied increased their charge account. Charge accounts were used most extensively by families living in villages, also in the West and in the South.

One very important observation made is to the effect that the net increase in consumer debt was more than offset by net increases in savings of one kind or another or by decreases in liability. This is most encouraging to those who have feared that American families are sinking deeper and deeper into debt.

It is too bad that the author could not have planned the investigation and supervised the collection of the data. The study would then have been an exceedingly valuable one.

LOUIS N. ROBINSON

PUBLICATIONS RECEIVED*

* Annual reports and publications presenting statistics collected at regular intervals have been omitted from this list. Some items of minor interest to statisticians have also been omitted. The contents of periodical publications are not listed, but the attention of the reader is directed to the lists of articles in current publications which are to be found in the *Revue de l'Institut International de Statistique, Journal of the Royal Statistical Society, American Economic Review, Population Index, Transactions of the Actuarial Society of America, The Record of the American Institute of Actuaries,* and *Sankhyā The Indian Journal of Statistics.*—Editor.

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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Table of Powers, Giving Integral Powers of Integers. Mathematical Tables Volume IX. New York: The Macmillan Company. 1940. xii, 132 pp. $4.25.

ECKERT, W. J. Punched Card Methods in Scientific Computation. New York: The Thomas J. Watson Astronomical Computing Bureau, Columbia University. 1940. ix, 136 pp.

ESTEY, JAMES ARTHUR. Business Cycles, Their Nature, Cause, and Control. New York: Prentice-Hall, Inc. 1941. xvii, 544 pp. $5.00 (trade). $3.75 (school).

FOOD RESEARCH INSTITUTE. Rice and Wheat in World Agriculture and Consumption, by V. D. Wickizer. Stanford University: Wheat Studies of the Food Research Institute. Vol. XVII, No. 6. March, 1941. 53 pp. $1.00.

—— World Wheat Survey and Outlook, January 1941, by Helen C. Farnsworth, and Bernhardt M. Jensen. Stanford University, California: Wheat Studies of the Food Research Institute. Vol. XVII, No. 5. January 1941. 39 pp. 75 cents.

FORD, ROBERT S., and SHEPARD, E. FENTON. The Michigan Retail Sales and Use Taxes. University of Michigan, Bureau of Government. Michigan Governmental Studies, No. 5. 1941. viii, 154 pp.

FOULKE, ROY A. The Balance Sheet of the Future. New York: Dun & Bradstreet, Inc. 1941. 99 pp.

GUTHRIE, JOHN A. The Newsprint Paper Industry, An Economic Analysis. Cambridge, Massachusetts: Harvard University Press. 1941. xxiii, 274 pp. $3.50.

INSTITUTE FOR RISK ANALYSIS. How To Start a Life Insurance Program. Cambridge, Massachusetts. 32 pp. 50 cents.

INTERNATIONAL LABOUR OFFICE. The Labour Situation in Great Britain, A Survey: May-October 1940. Studies and Reports, Series B (Economic Conditions) No. 34. Washington, D. C.: International Labour Office. 1941. 56 pp. 25 cents.

—— Studies in War Economics. Montreal, Canada. 1941. 199 pp. $1.00.

LEONTIEF, WASSILY W. The Structure of American Economy, 1919–1929, An Empirical Application of Equilibrium Analysis. Cambridge, Massachusetts: Harvard University Press. 1941. 181 pp. $2.50.

LESTER, RICHARD A. Economics of Labor. New York: The Macmillan Company. 1941. xv, 913 pp. $3.75.

MEGRAH, MAURICE. The Organization and Functioning of Branch Banking in England and Wales. New York: American Economists Council for the Study of Branch Banking. 1941. 37 pp.

MILLER, JOHN PERRY. Unfair Competition, A Study in Criteria for the Control of Trade Practices. Cambridge, Massachusetts: Harvard University Press. 1941. xiii, 438 pp. $4.00.

MOULTON, HAROLD G. Fundamental Economic Issues in National Defense. Pamphlet No. 26. Washington, D. C.: Brookings Institution. 1941. 32 pp. 25 cents.

POLLOCK, JAMES K. The Initiative and

Referendum in Michigan. University of Michigan, Bureau of Government. Michigan Governmental Studies, No. 6. 1940. 100 pp.

RODKAY, ROBERT G., Editor. Bank Operations, Proceedings of the Third Annual Michigan Bankers Association Study Conference. University of Michigan, Bureau of Business Research. Michigan Business Papers, No. 10. 1941. 63 pp.

SOCIAL SCIENCE RESEARCH COUNCIL. Topics for Research Concerning Public Assistance Programs. Washington, D. C.: Committee on Social Security of the Social Science Research Council. Pamphlet Series No. 6. February, 1941. v, 72 pp.

SIMPSON, KEMPER. Big Business, Efficiency and Fascism, An Appraisal of the Efficiency of Large Corporations and of Their Threat to Democracy. New York: Harper & Brothers. 1941. x, 203 pp. $2.50.

SPIEGEL, HENRY WILLIAM. Land Tenure Policies at Home and Abroad. Chapel Hill, North Carolina: University of North Carolina Press. 1941. xii, 171 pp. $3.00.

SPURRIER, LEO. Common Stocks and Bonds as Long-Term Investments. University of Chicago, School of Business. Studies in Business Administration, Vol. XI, No. 2. viii, 91 pp.

STAFFORD, PAUL TUTT. Government and the Needy, A Study of Public Assistance in New Jersey. Princeton, New Jersey: Princeton University Press. 1941. xiv, 328 pp. $3.00.

STIGLER, GEORGE J. Production and Distribution Theories, The Formative Period. New York: The Macmillan Company. 1941. vii, 392 pp. $4.25.

TAYLOR, MAURICE. The Jewish Community of Pittsburgh, December 1938. iv, 195 pp.

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WEST, CARL J. Introduction to Mathematical Statistics. Columbus, Ohio: College Book Company. Revised Edition. 1941. 159 pp. $2.50.

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ZAHN, FRIEDRICH. Die Statistik im nationalsozialistischen Grossdeutschland. Muenchen: Allgemeines Statistisches Archiv. 1940. 23 pp.

ZIPF, GEORGE KINGSLEY. National Unity and Disunity, The Nation as a Bio-Social Organism. Bloomington, Indiana: The Principia Press, Inc. 1941. xix, 408 pp. $3.50.

Government Publications

DEPARTMENT OF AGRICULTURE. Farmers in a Changing World. Yearbook of Agriculture. 1940. xii, 1215 pp. $1.50.

—— (cooperating with the National Bureau of Economic Research, Inc.) Gross Farm Income and Indices of Farm Production and Prices in the United States, 1869–1937, by Frederick Strauss and Louis H. Bean. Technical Bulletin No. 703. December 1940. v, 154 pp.

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SOCIAL SECURITY BOARD, BUREAU OF EMPLOYMENT SECURITY. Adequacy of Unemployment Compensation Benefits in the Detroit Area During the 1938 Recession. Employment Security Memorandum No. 14. January 1941. viii, 72 pp. 15 cents.

—— BUREAU OF OLD-AGE AND SURVIVORS INSURANCE. Old Age and Survivors Insurance Statistics, Employment and Wages of Covered Workers, 1938. 1940. xxiii, 268 pp.

—— BUREAU OF RESEARCH AND STATISTICS. An Outline of Foreign Social Insurance and Assistance Laws. Bureau Report No. 5. ii, 62 pp.

TARIFF COMMISSION. Starches, Dextrines & Related Products. Report No. 138. Second Series. xii, 182 pp. 30 cents.

TEMPORARY NATIONAL ECONOMIC COMMITTEE. Investigation of Concentration of Economic Power: Price Behavior and Business Policy, Monograph No. 1; Families and Their Life Insurance, A Study of 2,132 Massachusetts Families and Their Life Insurance Policies, Monograph No. 2; Industrial Wage Rates, Labor Costs and Price Policies, Monograph No. 5; Export Prices and Export Cartels (Webb-Pomerene Associations), Monograph No. 6; Measurement of the Social Performance of Business, Monograph No. 7; Toward More Housing, Monograph No. 8; Taxation of Corporate Enterprise, Monograph No. 9; Industrial Concentration and Tariffs, Monograph No. 10; Profits, Productive Activities and New Investment, Monograph No. 12; Relative Efficiency of Large, Medium-sized, and Small Business, Monograph No. 13; Hourly Earnings of Employees in Large and Small Enterprises, Monograph No. 14; Financial Characteristics of American Manufacturing Corporations, Monograph No. 15; Antitrust in Action, Monograph No. 16; Trade Association Survey, Monograph No. 18; Government Purchasing—An Economic Commentary, Monograph No. 19; Taxation, Recovery, and Defense, Monograph No. 20; Technology in Our Economy, Monograph No. 22; Agriculture and the National Economy, Monograph No. 23; Consumer Standards, Monograph No. 24; Recovery Plans, Monograph No. 25; Economic Power and Political Pressures, Monograph No. 26; The Structure of Industry, Monograph No. 27; Survey of Shareholdings in 1,710 Corporations with Securities Listed on a National Securities Exchange, Monograph No. 30; Economic Standards of Government Price Control, Monograph No. 32; Geographical Differentials in Prices of Building Materials, Monograph No. 33; Control of Unfair Competitive Practices Through Trade Practice Conference Procedure of the Federal Trade Commission, Monograph No. 34; Large-Scale Organization in the Food Industries, Monograph No. 35; Reports of The Federal Trade Commission on Natural Gas and National Gas Pipe Lines in U. S. A., Agricultural Implement and Machinery Inquiry, Motor Vehicle Industry Inquiry, Monograph No. 36; A Study of the Construction and Enforcement of the Federal Antitrust Laws, Monograph No. 38; Control of the Petroleum Industry by Major Oil Companies, Monograph No. 39; Regulation of Economic Activities in Foreign Countries, Monograph No. 40; The Basing Point Problem, Monograph No. 42; The Motion Picture Indus-

try—A Pattern of Control, Monograph No. 43.

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